CIVIL ENGINEERING

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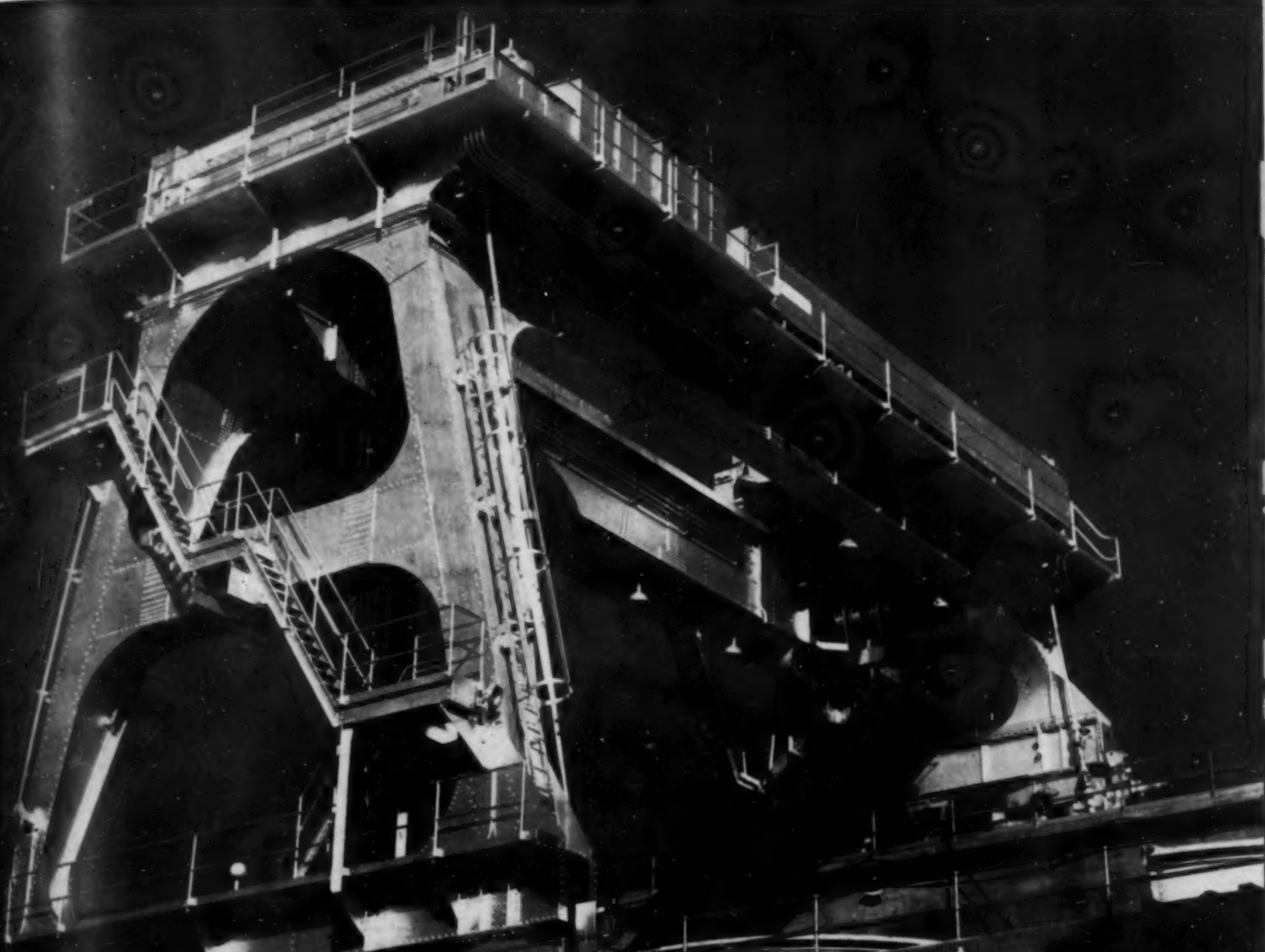

Functional Design in a Heavy Gantry, Wheeler Dam—See Page 310

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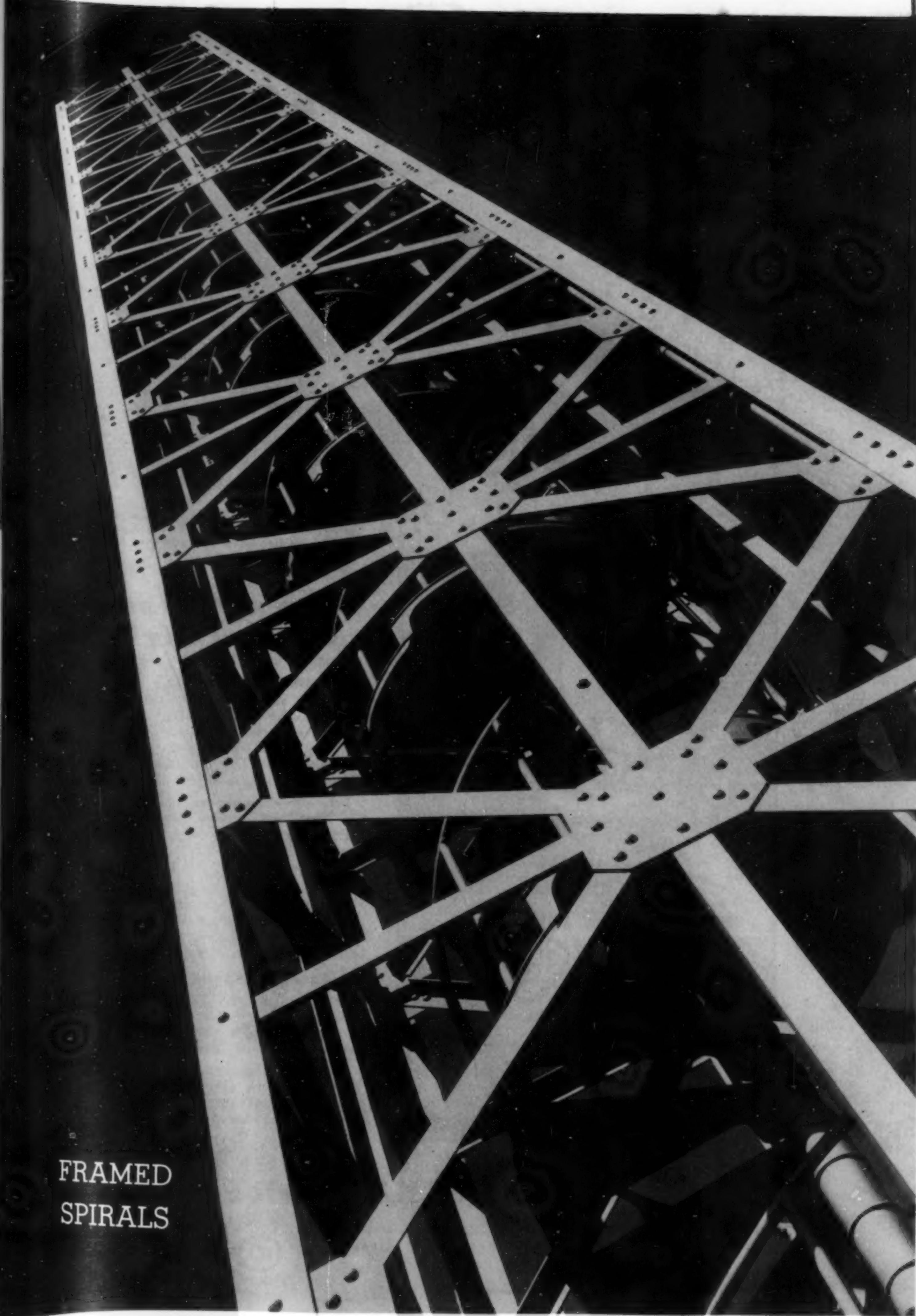
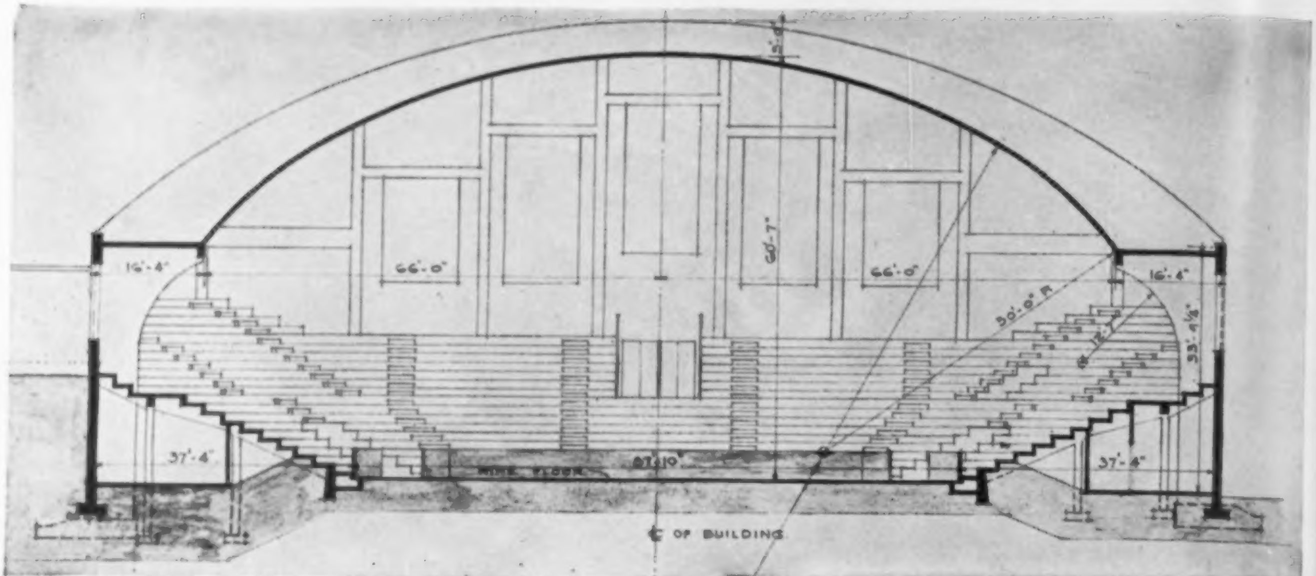
MAY 1941



FRAMED SPIRALS

COMPLETED 6½ WEEKS SOONER



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Among Our Writers

ROBERT E. DOHERTY (U. of Ill., '09; Union College, M.S., '21) has been president of the Carnegie Institute of Technology since 1936. He was associated for more than 20 years with the General Electric Co., for a time as assistant to Dr. C. P. Steinmetz, and then was called to Yale, where he was successively professor of electrical engineering and dean of the school of engineering. He has been awarded the honorary degree of M.A. by Yale and that of LL.D. by Tufts College and the U. of Pittsburgh.

PERRY A. FELLOWS was city engineer of Detroit 1925–1931. He designed and constructed the Detroit City Airport and was its director 1931–1933. Since 1933 he has been administratively associatd with federal work-relief activities—as assistant chief engineer of the Civil Works Administration (1933–1934); administrative officer of the Federal Emergency Relief Administration (1934–1935); and as assistant chief engineer and director of the Municipal Division of the WPA, before receiving his present appointment in December 1940.

ARTHUR W. ARLT (R.P.I., C.E., '29) has been associated with the Bureau of Reclamation for the past 7 1/2 years. For 5 years he was engaged in special studies of temperature control of mass concrete in Boulder and Grand Coulee dams, and the past 2 1/2 years has been assigned to general and special work related to designs for dams.

B. A. POOLE (Purdue) was assistant engineer for the Indiana State Board of Health, Bureau of Sanitary Engineering, 1931 to 1935, when he took up his current duties. Since then plans for sewage works costing more than $25,000,000 have been handled through his office.

CARL I. ASLAKSON (U. of Minn.), after serving in World War I as a Lieutenant of Marines, entered the Coast and Geodetic Survey in 1923. Hydrography, topography, and geodesy have taken him from Alaska to the Philippines. He is now in South America on gravity measurement work.

STUART C. GODFREY (U.S.M.A.) has also completed graduate work in various Army schools including the War College. He has served in connection with the Wilson Dam, the Panama Canal, and Mississippi River improvements; has commanded regiments in Germany and Panama; and writes with authority on the organization and training of engineer troops.

E. R. YOUNG attended Texas A. and M. College in 1923 and 1924 and has been employed by the Texas Highway Department continuously since then. He supervised the construction of the first sand-shell admixture project in 1940 and is now completing the second such project.

R. T. PINCHBACK, JR. (Texas A. and M. College) has worked for the Texas Highway Department 5 1/2 years and has been with Mr. Young on the two sand-shell admixture projects.

HENRY C. TAMMEN (U. of Calif.) after 3 years of miscellaneous experience began work in 1909 with Waddell and Harrington and served in various capacities with this firm and its successor, until 1928 when his present partnership began.

ELLIS E. PAUL (U. of Kans., B.S. '22, C.E., '31) for 7 years after graduation was employed by Harrington, Howard and Ash in the design and supervision of construction of movable bridges and has had his present association since 1928.

NICHOLLS W. BOWDEN (La. State U. '08; C.E. '28) has spent about 20 years with the Corps of Engineers, in the Chattanooga and Nashville (Tenn.) and Pittsburgh (Pa.) Districts on navigation, flood control, and hydroelectric projects. He was also in state highway work in La. for 6 years, and became state highway engineer in 1927. He has held his present position with the TVA since 1926 and has been water consultant for the National Resources Planning Board in the Tennessee and Cumberland River basins.

R. A. CAUGHEY (Pa. State Col., '07; C.E. '16), for 3 years after graduation did surveying and drafting work on railroads, highways, and bridges. He became an instructor of civil engineering at Pa. State in 1910 and assoc. prof. in 1914. Since 1919 he has been at Iowa State, receiving his present rank in 1930. He is active in professional affairs and is a frequent contributor to the literature of structural mechanics.

E. GEORGE STERN (Tech. U. Munich, '36; Pa. State Col., M.S., '38) has been a faculty member in charge of timber research, at Pa. State College since 1936. His timber bridge design work has received wide recognition, and he is co-author of a paper on Superpressed Plywood (*Mech. Eng.*, Vol. 62, Nos. 3, 10).

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RELOCATING PIPE SAVES DEFENSE DOLLARS

This cast iron water main laid at Ft. Jackson, S. C., in 1917

—was recently lowered under pressure after 23 years' service

—with an offset in the line of about 15 feet.

Note cast mark (1917). Pipe was laid during World War 1.

"This group of photog illustrates the lowering 16-inch cast iron water at Fort Jackson, South lina, in connection wi present National Def program. This line was inally laid in 1917, d the last world war, as d by cast marks (see l right). The line was low under pressure and aft years of service, no l were found and the pip naturally in perfect c tion. There is an offset i line of about 15 feet nothing but straight was used." (The fore is a simple transcripti the statement subm by the contributor o photographs.)

Note for Water Works The original use of cas pipe made this money- operation possible.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Complacency in Confusion

From a Recent Address to Students at the Carnegie Institute of Technology, Pittsburgh, Pa.

By Robert E. Doherty

President of the Institute and Chairman of the Engineers' Council for Professional Development

MOST people live in a state of complacent confusion. College students and graduates are no exceptions. How many of them, for instance, have only a vague and confused notion of the fundamental principles of their professional study or practice; how many of them are content to live without a clearly thought-out philosophy of life; how many of them are inclined to think with their emotions instead of with their minds; how many, disillusioned by events of the past decade, are intellectually lost and assume the role of the cynic; how many, I ask, thus bear their own evidence of confusion? I believe you will agree with me that the number is discouragingly great.

Results Are Serious.~If the consequences were personal only—if they were merely the unrewarded personal careers, or the travail of minds that see no way out of new and trying situations, or the sterile satisfactions that go with intellectual poverty—they would be serious enough. But the consequences do not end there. They become national in scope when confused minds decide matters of destiny, for our democracy rests full-weight upon the proposition that the people are competent to determine their destiny. If they depend upon leadership, as they must, and leadership is confused, the consequences in national and local community life must be devastating—and indeed they have been devastating. By leadership I mean every policy-making body or policy-making person in the country, whether in business, industry, education, or government.

In the confused and demoralized world in which we now live, and which certainly will become more confused and more demoralized, there is a great challenge to the college students of America. It is the challenge to become intellectually prepared to deal with such a world.

New Precepts Needed.~The formulas of day-to-day contemporary life will not suffice because many of them will not apply to the new situations. New formulas must be thought out, and in this thinking there must be a return to the very fundamentals of science and living. There must be a clarification of basic philosophies—personal, professional, social. There must be clear, straight thinking. And to have these there must be genuinely educated people. Walking encyclopedias and handbooks will accomplish little. College graduates who have learned only the routine skills and formulas of their work will be intellectually lost in a world of new problems and thus will be ineffective in determining either social or individual destiny. There must be an intellectual renaissance, and that is your challenge.

Does the habit of confusion and superficiality among so many college graduates stem from an inherent lack of intellectual capacity? It is a long, hard struggle for most of us really to learn the art of constructive thought, but many of us have more capacity for understanding and for intelligent thought than we are given credit for having. In college we may be slow in getting our thinking gears into mesh; and if while we are trying to get them into mesh the external machinery of classroom procedure moves too fast, the gears get stripped. Then disorder and confusion result. However, with a little more patience and a little more emphasis at the right points, more of us might have got our mental machinery into gear and successfully made the shifts until we got into high gear. No, I do not accept the view that inherent limitations of mind fix the intellectual achievements of college graduates at their present levels. We all have our own limits, of course, and these are not the same for everybody; but I am convinced that there is still good leeway between actual and potential intellectual achievement. So we must look elsewhere.

We Strip the Gears~The trouble is that too much is undertaken in the time available. In the modern curriculum there is so much subject matter to be covered that in the time available few, if any, students can cover all of it with understanding. The result is that they do not understand much of what they have covered or only partly understand it. They come to depending more and more upon memorizing, and less and less upon understanding. This process of racing through with one eye on the next quiz, pages of words and formulas with half understanding or no understanding, is utterly demoralizing. With such a habit firmly established in college, it naturally persists afterward; and thus confusion and superficiality mark the minds of too many graduates. It is therefore a deplorable fact that the

college diploma is usually not a certificate of a cultivated mind.

Proving the Product.~The test for identifying a cultivated mind is to face it with perplexities—to face it with new situations not in the books but involving principles and knowledge which that mind has studied. Then see how it behaves. Does it grab for straws, does it become emotional, is it evasive, does it give up? Or does it try to anchor to principle, does it have a philosophical base for its thought, has it essential knowledge, however limited, that will give meaning to its principles and to its philosophy, and can it think logically in applying all of these to the understanding and solution of the new situations with which it is faced?

Do not rest upon the assumption that a college diploma tells the whole story. It does signify that you have completed a college program and it may also be a ticket to a job; but it is not a ticket to the ranks of intellectual competence or to a successful career. The most important thought in your educational career is this: Genuine education is to be achieved only by the acquisition of fundamental knowledge that is thoroughly understood, and by the development of a purposeful attitude of mind and of a competence in thinking your way out of perplexities.

Do not misunderstand—memorized information and formulas are of course important, indeed they are essential, but only so if they are thoroughly understood and furthermore are related in your own mind to a definite intellectual purpose. Then they cease to be miscellaneous information and become knowledge. For instance, it is futile to learn, however perfectly, the language of Newton's laws of motion unless the significance of the language is clearly comprehended in its relation to the tangible physical facts which these laws correlate; in other words, unless one can visualize and interpret a physical situation involving these laws.

Four Essential Elements.~Let me be more specific regarding the nature of genuine education as I conceive it. Of four essentials, the first is the acquisition of fundamental knowledge; that is to say, the learning and understanding of great basic truths and of a sufficient background of related fact to give definite and constructive meaning to those truths. As great truths I include those in the physical world, in the social and economic world, and in the realm of the human spirit. There are not many. I refer to such principles as the law of conservation of energy; the law of diminishing return; the principle underlying the golden rule. There are of course hundreds, perhaps thousands, of principles and formulas derived from such basic truths, much as the numerous theorems of geometry are derived from a few fundamental premises; and then there are perhaps a few hundred more based upon somebody's opinion. But it would be both hopeless and futile to try to learn all of them. One must discriminate between these and the great truths that form the bedrock of intelligent thought.

A second element is the development of a philosophy of life. This is a long process. It is settling upon basic purposes and attitudes in life and the reasons for them; it is placing the indispensable underpinnings of faith and courage and self-confidence. It is a continuing building process—the process of testing against the experience of your own life and the recorded lives of others, those purposes and attitudes that are tentatively adopted, and of thus selecting and fitting in, piece by piece, the structural units of a life purpose. For instance, one important and immediate unit is professional purpose. I do not mean the specific details and place of your future work, but the broad lines of professional activity that now seem to offer the greatest promise of those satisfactions which you have come to cherish.

Also Moral Bases.~Next I mention humane appreciation. A mind or life that shuts itself off from an understanding of man as a human being; that shuts itself off from an appreciation of the desires and disappointments, the yearnings and satisfactions that motivate human activity; that shuts itself off from an appreciation of the literature and arts through which the human soul has attempted to express itself—such an isolated mind or life is only half human—not genuinely educated.

Finally I come to intellectual competence. Without this competence the other elements would represent merely passive satisfactions. Such satisfactions are of course important fruits of education. But they do not constitute a whole; they are complementary to another fruit—the fruit of constructive thought. And to achieve this competence in thinking one's way out of perplexing situations is to round out that genuine education which I am urging upon you.

Do you want that kind of an education? Do you wish to prepare for keen competition? Do you wish to preserve your precious liberty of thought, speech, and worship? If you want these things you can have them, provided you pay the price. It is the price of taking the initiative in your educational work. This demands greater resolution than merely following the regimen of class work. It requires greater devotion to purpose.

Conquest by the Mind.~The kind of education I am proposing cannot be given to you; you must win it by hard intellectual struggle in which you take the initiative. The faculty may inspire you to intellectual effort, but you must exert it; the faculty can help you to understand, but you have to do the understanding; the faculty can coach you in the art of logical thought, but you must do the thinking; and the faculty can help you to cultivate good taste and humane appreciation, but you have to do the cultivating. Every time you struggle with a new concept and master it you will have added to your intellectual stature. Furthermore, every time you make use of such a law or theory or concept to think your way out of a perplexity or to experience a new appreciation, you will have achieved another and further intellectual advance. But in both cases you must do the job. You, not the coach, must carry the ball.

So I urge you to take the initiative and learn to use your heads. In the first place, dig yourself out of confusion. Do away with superficiality! Stop memorizing words and formulas that you do not understand, merely for a grade. Insist on understanding! Then, under the guidance of the faculty in your regular class programs, but under your own initiative, you will be in position to go forward more effectively and more rapidly with the acquisition of great truths, the evolution of a philosophy of life, the cultivation of humane appreciation, and the development of intellectual competence—in other words, a genuine education gaged to the demands of the changing world in which you will live.

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Volume 11 May 1941 Number 5

Engineering Significance of the WPA

Capital Values of Completed Construction Are Merely By-Product—Community Values Are Reflected in Paid Grocery Bills, Sustained Retail Markets

By Perry A. Fellows, M. Am. Soc. C.E.
Chief Engineer, Work Projects Administration, Washington, D.C.

The prosaic statement of the current relief act that its purpose is to provide work for needy persons is misleading in its simplicity. To a greater extent than many people are aware, the influence of the program extends far beyond this limitation to affect many groups other than the unemployed. The civil engineering profession, in particular, has been brought into closer touch with the life and affairs of the nation. Mr. Fellows is in a position to assess the WPA influence from a perspective that few can claim, and to present a point of view that is especially helpful in interpreting this activity to Society members.

The awful days of widespread unemployment and want are not so far back in the history of our country that they are difficult to remember. It may be a private tragedy for one man to be hungry with no way to earn his food, but it is certainly a public concern when such people number millions. What might have been a local concern if want had existed only in isolated areas, was an undeniable national crisis when the sufferers were found throughout the country—east and west, north and south. Everywhere both the cause and the cure were beyond the ability of local officials trying to cope with the crisis.

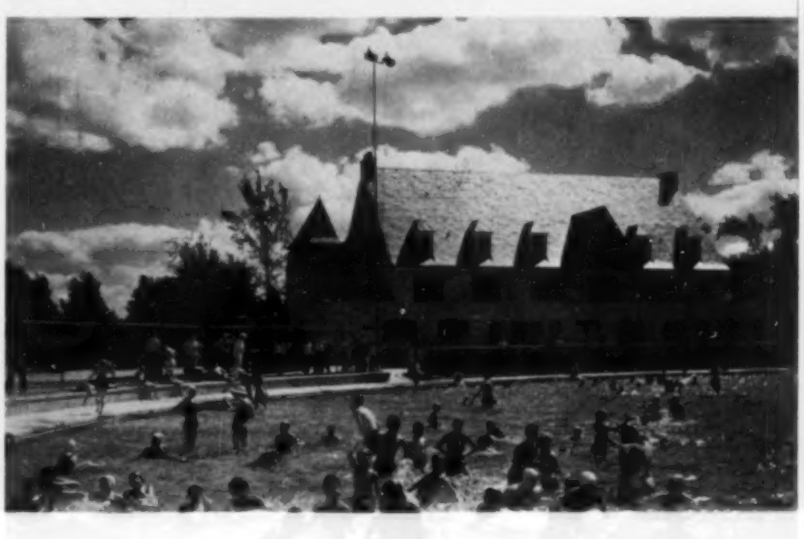
Private work was not to be had, therefore public work was the American way of answering the call. Public work in the usual sense of the word was not enough—it had to be public work that would provide employment for a destitute people. Since the people could not be drafted to fit a project, the projects had to be designed to fit the skills and abilities of those to whom the tragedy was closest. This determined the kind of work as well as its location. If the traditional way of doing the work called for a complete shutdown during cold weather, that tradition could no longer hold. People had to have food even in cold weather, and the need for shelter and clothing was even greater then. To get the food they must have wages. So the work must be carried on.

Although a village might really need a new city hall of brick or stone, which would require the services of the highly skilled trades, such construction might serve no useful purpose in providing employment for unskilled men and women or for those whose skills were elsewhere than in the building trades. Thus in planning a program of such magnitude and range, the engineer and others in charge have had to keep in mind the fact that the location of the work proposed and the character of that work were to be determined largely by the incidence of need with respect both to the locality and to the labor groups affected.

Useful public works, of course, are not something new and unheard of under the sole proprietorship of the federal government. It may well be asked, whose projects are they? Who is the owner? In whom will the title rest when the job is done? Who will maintain the road, cut the grass in the new park, or teach the children in the new school? Not Uncle Sam alone. The government will do its part—it will provide projects. But the road is a state highway and remains that; the park is a city park, and the park board must see that the grass is cut; the school board must hire the teachers for the children who are to attend the new school.

The various departments of the federal government have their projects, but those departments or bureaus have been created for certain purposes and cannot get very far away from their established authorizations—the law will not let them wander all over the lot.

Thus we identify the people for whom the work is to be done—the sponsors. This sponsorship may be that of one of the federal agencies or of a state or local subdivision of the government. Private sponsorship is not allowable. Some of the people thus drawn into the program in an official capacity may not be sympathetic. They may not be fully aware of the need for the program. In such cases, those who are aware of the need for the work, who are acquainted with the authority under which the work can be done and the possible accomplishments—whether these people be WPA employees or others—are often the ones who, by virtue of such knowl-



Community House and Pool—Forest Park, Ill.

ARMORY AT SPANISH FORK SERVES DEFENSE
The WPA Had Built 36 New Armories and Improved 95 Similar Buildings by June 30, 1940

edge and understanding, become responsible for the promotion of the program.

Because of his training and experience, the engineer often has this capacity—that of being able to interpret possible public works construction, blueprints, and plans and specifications, into terms of detailed work for local unemployed people. He becomes ingenious in devising new plans for community financing for such work. We also find him devising new community facilities, such as swimming pools, ski slides, and recreational centers that under other circumstances would be passed by with little if any sympathy because of the fact that they seem to lack usefulness for the community.

In this business of promotion and sharing, the engineer representing the sponsor is very apt to get his initial first-hand experience with the red tape that so often seems to restrict the opportunities to do things quickly and in the grand way. So many plans, so many statements, so many useless requirements—he thinks they must have been designed by some bureaucrat for that official's own amusement or aggrandizement. It may be that the engineer has had relatively little previous experience with the federal government, but is fairly well informed as to local procedures. If he does not encounter this red tape before he gets a project devised and submitted for consideration, he may discover it in the course of getting official approval for the work. Then he will be sure it is a Washington contrivance.

Many engineers have made trips to the capital to exercise their prowess at cutting through this barrier for the sponsor. I think such trips are often more helpful for other reasons than for the accomplishment of their original purpose. I am sure some visiting engineers have come to realize that project information, which appears so obvious from the top step of the local city hall, is not quite so clear in the incomplete project documents submitted for consideration in Washington. Is the building to be on public property? Silly question! Everyone in town knows the deal by which the city came into possession of that lot five years ago. Perhaps so, but no one on the Washington staff was reading the local paper which carried that news five years ago.

So we must consider the federal employees too—the public servants charged with conducting the public works

A WOODED DRIVE IN INTERSTATE PARK, N.J.

program and maintaining the integrity of the projects. They should be constantly aware that the work must go forward, but they can never forget that it is a public trust they have undertaken. It is easier to say "Yes" than "No," and "Yes" might often speed the work that needs so badly to be rushed. But a public servant must consider the public's interests first, last, and all the time. His own personal wishes or inclinations cannot be allowed to govern.

George Washington expressed this obligation a century and a half ago when he said: "Do not suffer your good nature, when application is made, to say 'Yes' when you ought to say 'No.' Remember that it is a public not a private cause that is to be injured or benefited by your choice."

At heart, federal employees are just as impatient of delay as anyone. But there are laws and rules and regulations, as well as their own obligations to prevent them from being impetuous, thoughtless, or over-enthusiastic. As a matter of fact, the great Federal Works Agency of which the WPA is a part, has less bureaucratic entanglements about it than its most ardent advocates would have dreamed possible ten years ago. Engineers throughout the country long awaited the establishment of such a federal agency. Now it is here and doing business, encumbered by less red tape than would once have been thought possible.

The responsibility for the engineering integrity of each of the 50,000 projects in the 48 states, Hawaii, and the Virgin Islands cannot successfully be passed to Washington. To attempt it would require, first, the formation of the largest and most versatile engineering organization ever imagined. Such engineering responsibility is more wisely left in the hands of local engineering officials and their consultants.

SEWAGE DISPOSAL PLANT FOR MUNCIE, IND.
Sanitary Facilities Have Been Constructed in Every State

The projects must be selected, planned, and put into operation with the flexibility requirement in mind. A building, started when many building-trades workers are unemployed, may long remain unfinished if these skilled operators are called back to private employment. Other useful units may be finished with less difficulty. So it is not unusual to see WPA projects undertaken in a different manner from that which would be followed if it were certain they were to be carried straight through to a speedy conclusion with "time of the essence." This

An Example of Swamp Land Made Useful—Municipal Stadium at New Boston, Ohio

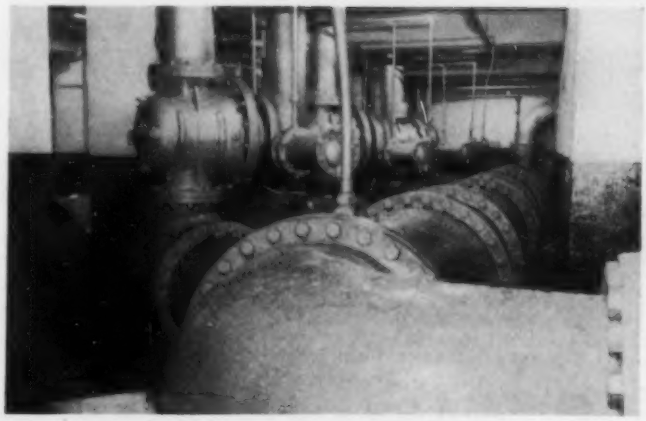
is another concession to the distinctive nature of the program.

Why not carry through regardless of relief needs? Because this would also violate another principle of project operation—it would compete with private enterprise. The Work Projects Administration has leaned backward in its effort to avoid competition. Some of this restraint is dictated by the law. Most of it results from realization of the fact that such competition would lead to a vicious circle.

Since the program was devised to meet the emergencies of unemployment on a vast scale, it would be unwise to undertake as a part of the program anything that would provoke disemployment. This has deprived the program of many kinds of useful work. For instance, in many cases material has been purchased when it could have been made as a part of the project with greater economy of funds. The same principle led to the attempt to use contract methods in the initial stages of the program. This was abandoned for the day-labor system only when it appeared impossible to reconcile the primary objectives of the WPA with those of the contractor. In this connection a reconciliation has been worked out, which results in a modified form of contract covering non-labor items and leaving the laborers for WPA employment to be paid with federal checks.

The effort to avoid competition carried with it engineering problems of considerable significance. Such questions as these are sometimes asked of engineers: Couldn't this work be done more efficiently by others? Why drain this swamp now? Why not erect a new school house instead of grading a play field? Why did the government let a contract for the new post office but use the day-labor method of operation for the WPA street project? Since these questions impinge on the field of activity in which the engineer stands as an authority, he should be able to answer them correctly and without prejudice.

Consider the fairly common, almost standard, concepts that are ordinarily used in appraising the physical aspects of public works. "A million-dollar sewer," "the highest structure in the state," "a six-lane highway" are familiar expressions often tied in with the purpose to be served or with arguments as to the dollar cost of the



Portsmouth, Ohio, Gets Heavy-Duty Pipe Line Installed by the WPA

work to the taxpayer. But the directive under which the WPA operates is fundamentally different from that generally controlling public works; therefore a proper evaluation cannot be made on the same basis.

The selection of personnel, flexibility of organization, and the implications of competition are determining factors. Choice of project, planning, and method of operation are all subject to unique controls. The organization is a tool for the creation of much-needed public works, a tool too valuable to be thrown away or overlooked when every ounce of the nation's strength is needed in its preparation for defense.

Activity on WPA projects is not stimulated by the prospect of a bonus for anticipating a prearranged completion date. Total WPA work is not a direct function of the need for the completed projects. Volume of physical accomplishment depends primarily on the number of unemployed people eligible for the assignment. Thus the desired quality of the finished performance is more likely to govern the individual worker's speed than is the estimated completion date.

However, there is another factor that is also instrumental in determining the rate of accomplishment measured in terms of bricks laid or cubic yards of dirt moved. That is the extent of mechanization. The adjustment between men and machines is variable, but this variation is subject to certain controls. Congress has limited the extent to which the WPA can adopt modern labor-saving, speed-securing devices out of the relief funds. There is a floor but no ceiling to what the sponsor contributes. This control is an average rather than a fixed ratio applicable to each individual project, and thus it is quite possible for the indifference or inability of the sponsor to bring about project operations

WPA Places Mount Greenwood Sewer—Chicago

TWENTY MILES OF BELT LINE TRACK REBUILT FOR THE SAN FRANCISCO WATERFRONT

that fall short of the degree of mechanization we would like to see.

This lack of mechanization influences unit costs too. The old standards of unit costs of finished projects should be applied only when all relevant facts are taken into consideration. It must be kept in mind that primarily we are employing men.

The costs of man-months of useful work are the unit costs to watch first, then the cost of the end products. It would defeat the purposes of the program to reverse this order, just as surely as it would if a sewage disposal plant were to by-pass raw sewage to afford better control of the fertilizer by-product. We must not let these ideas of unit cost and efficiency prejudice our judgment until we have cleared our minds of old concepts that were based primarily on securing something at one cost and reselling at another, higher level.

Because of varying requirements there have been changes other than those of method. WPA work is largely contra-seasonal because it must fit the layoff periods in private industry. A high turnover of labor is a necessary part of the program, and a wide variety of useful projects must be ready for operation to absorb the available relief load. As could be expected, these conditions increase the accident hazards on construction projects, and more than usual attention must therefore be given to the safety of WPA workers.

In this connection, however, it is interesting to note that the frequency and severity of injuries sustained by workers on WPA construction projects compare favorably with the records of private contractors engaged in similar activities. The percentage distribution of accidents by types and causes also is approximately the same as on private contract work.

In spite of the fact that the WPA is a program of finding jobs for men rather than of finding men for jobs, a considerable body of work has been accomplished. An inventory shows 517,431 miles of highways, roads, and streets constructed or improved from the beginning of the program through June 30, 1940. Bridges and viaducts reconstructed or improved number 39,794, while 64,426 were built new. New utility plants numbering 1,736 have been built. These include pumping stations, power plants, incinerators, and sewage disposal and water treatment plants.

GEODETIC SURVEYS NO OBSTACLE
Triangulation Tower Erected as Part of Massachusetts State-Wide Program

Practically all the work on airports during the past five years has been carried on as a part of this program. Improvement or reconstruction has been applied to 317 landing fields, and 197 new fields have been provided. A total of 1,088 airport buildings have been reconstructed or improved, while 474 new airport buildings have been provided. Other new public buildings now number 25,796, and 67,724 have been improved.

For flood and erosion control and for conservation, 15,815 new dams have been built. Also 6,926 miles of stream-bed improvement have been provided, and during the same period 4,118 miles of river-bank and shore improvement and 960 miles of ditches, canals, pipes, or flumes for irrigation have been completed.

The execution of a broad program for the construction of public works improvements under the WPA has accentuated the need for accurate engineering surveys and the preparation of much-needed maps. The WPA program includes geodetic control, topographic and geologic surveys, and in fact practically all types of engineering surveys and the preparation of various kinds of maps.

National defense is a further impetus to engineering survey projects. The WPA is assisting in the execution of these projects and is furnishing valuable information to the War and Navy Departments. The same projects serve to make available survey and map information that could not have been obtained from local public funds for years. It is now generally recognized that the WPA can properly do the kind of work so often described in the pages of engineering magazines.

Congress, in the 1940 spring session, aware of the need for prompt defense activity, saw in the WPA a means of getting that action quickly. Here was an organization completely equipped to carry on. It reached from Washington to the most remote parts of the United States. It had demonstrated that it could function quickly when disaster or other demands released the bonds. Accordingly, provision was made whereby defense projects could be operated. Now the ratio of men to machines is changed when the Secretary of War or the Secretary of the Navy says "must." We see the WPA outstripping old organizations that are enmeshed in red tape or highly centralized or limited by law.

In Georgia an airport was needed. Overnight the WPA was equipped with a battery of twelve 12-yd carryalls to attack the job, and the red hills of Georgia literally melted. No doubt the work will be finished well ahead of the most optimistic estimate and possibly before this message is printed. That example will be repeated many times. Where the call for defense is not so urgent less of the funds are spent for high speed, but the men who otherwise would be idle are doing their share.

Thus we find that the engineer in new ways is being drawn by the WPA into the life of his community and his country. Of course the projects are of interest to engineers, but more than that, the entire WPA program is of the utmost engineering significance. I recommend the whole field for sympathetic study and well-considered counsel.

Tilt of Dams Measured with Optical Device

Portable Tiltmeter Developed for Study of Movements in Rock and Concrete Masses During Grouting

By Arthur W. Arlt, Assoc. M. Am. Soc. C.E.
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Use of grouting in the construction of dams has become so general and has assumed such importance that new methods and equipment for improving and controlling such operations have become of increasing interest and concern. Because the injection of grout produces elastic distortions and even permanent displacements in abutments or concrete masses, measurements of the minute movements of these bodies provide one means of controlling and observing the effects of grouting as that operation proceeds. In connection with numerous projects involving the construction of dams, engineers of the Bureau of Reclamation have recognized the importance of more precise control of grouting operations, and therefore have recently developed an extremely sensitive portable tiltmeter to indicate small heaving or tilting movements.

Instrument Utilizes Optical Lever Principle

This tiltmeter (Fig. 1) is an optical instrument composed essentially of a tripod frame, a telescope with filar eyepiece, a mercury pool with reflecting prism, and a light source. It will indicate rotational movements in the order of one second of arc in a vertical plane through the axis of the telescope.

Its design is based on a system of optical levers operating through a telescope in conjunction with a prism and a reflecting pool of mercury. To indicate the relative locations of the essential parts, a schematic diagram of the light rays in a tiltmeter rotated through the angle θ is shown in Fig. 2 (*a*). The diagram is restricted to a small pencil of rays of each group in order to avoid confusion.

The light source is mounted directly in front of a cross set in the plane of focus of the field of view, that is, at the focal distance f from the objective. This arrangement produces parallel rays after the diverging entering rays have passed through the objective. A $1^1/_4$-in. unsilvered right-angle prism is mounted over the mercury pool as indicated. Light rays which strike first the prism and then the mercury form an image (a yellow cross) at I_Y, while those that strike the mercury first form an image (a red cross) at I_R.

Distance between the images is measured by means of the filar eyepiece of which the field of view is shown in Fig. 2 (*b*). Since this distance is dependent only on the angle made by the rays with the axis of the objective, $\theta = {}^1/_2 \text{ arc tan } \dfrac{I_Y - I_R}{2f}$. When the angle of rotation, θ, is zero, the two images will be coincident at the center of the focal plane, or in other words, they will appear as a single cross image directly opposite the 5-mm mark on the filar eyepiece scale. For the convenience of the observer in identifying the direction of rotation, a red filter is mounted within the telescope in such a way that it intercepts a portion of the lights rays entering the objective and makes one of the images (I_R) red. When the rotation is positive, I_R will be on the bottom half of the field of view as shown; when the rotation is negative the position of the images in the field of view will be reversed.

As shown in Fig. 1, the complete instrument weighs about 20 lb, and when set up fills a space about 18 in. wide by 23 in. long and is approximately 20 in. high. When not in use, it can be folded and placed in a 20 by 26 by 7-in. fiber carrying case. Instrument and case together weigh 38 lb.

Frame construction is of 1-in. and $1^1/_4$-in.-diameter brass tubing for the outside members, $2^3/_4$-in.-diameter brass tubing for the telescope collars (through which the telescope slides into position in the frame), and $4^3/_4$-in.-diameter brass tubing for the mercury prism cell. All rigid attachments are made by brazing. Quarter-inch brass-plate "ears" are brazed to the two folding members of the frame and are provided with pin hinges. One hinge pin includes a thumb plate for convenience in demounting the instrument.

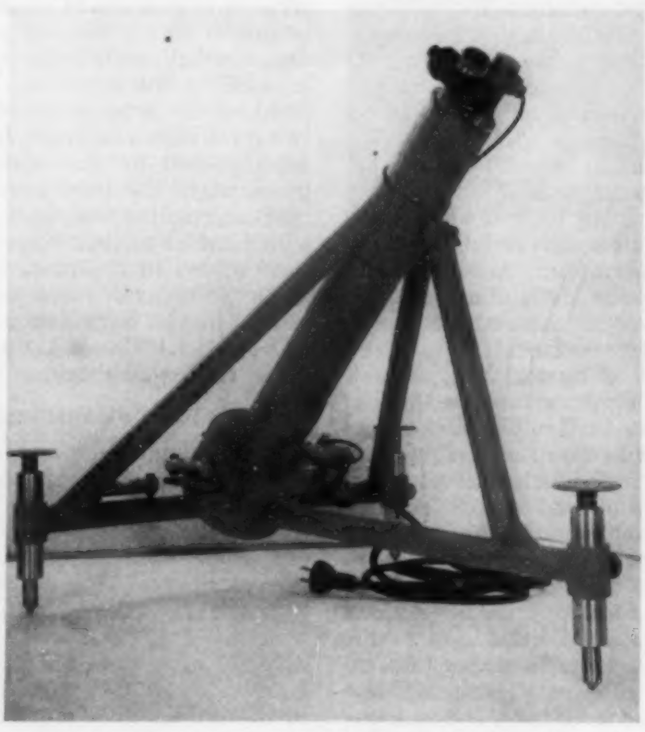

Fig. 1. Portable Tiltmeter Constructed by Reclamation Bureau

For normal use, three stainless-steel leveling screws, $^5/_8$ in. in diameter by 6 in. long, are provided, each having brass knurled heads 2 in. in diameter. These screws are threaded into polished brass sleeves 1 in. in diameter by 4 in. in length, appropriately tapped. For unusually steep set-ups or on rock pockets, a special 10-in. leg is furnished. This is provided with a standard sleeve and can be substituted for one of the regular 6-in. legs. Steel knurled thumb screws are provided for all sleeves to make adjustment of each leg independent over a wide range.

Two 3-in. level vials are mounted on the frame, their axes crossing at an angle of 90°. These are provided with studs and nuts for any field adjusting that may be necessary.

The mercury prism cell of brass tubing $4^3/_4$ in. in diameter, with insert bottom, is mounted at a vertical angle of 45° in the bottom of the frame. A cap with a collar, $2^3/_4$ in. in diameter, screws into the top of the prism case. The collar accepts the objective end of the

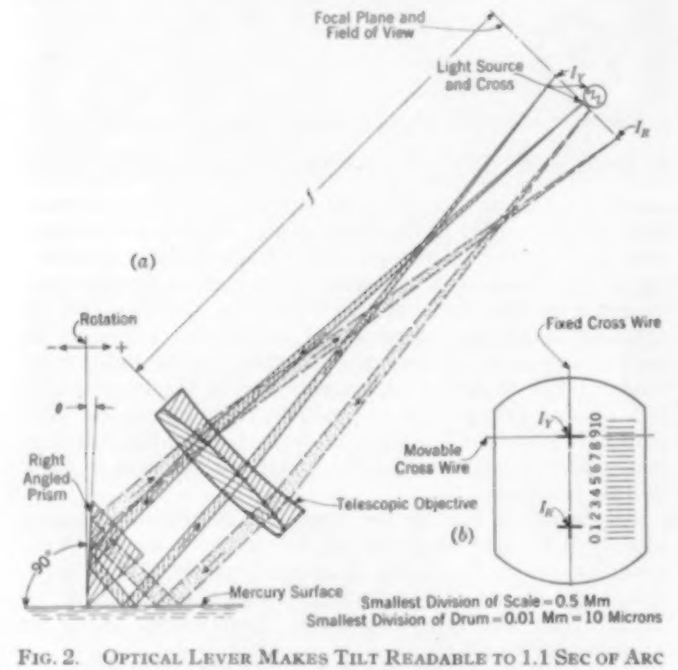

FIG. 2. OPTICAL LEVER MAKES TILT READABLE TO 1.1 SEC OF ARC
(a) Ray Diagram for Rotated Meter, (b) Field of View

telescope tube, and set screws hold the telescope firmly in place.

Soldered against one side of the prism case is a standard 115-v transformer for supplying 6 to 8-v current to the 3-w light source. A 25-ohm, variable, coil resistance attached to the transformer permits adjustment of potential to accommodate field variations.

The telescope collimator tube, constructed of $2^1/_2$-in.-diameter brass tubing, is usually about $16^1/_2$ in. long, depending on the focal length of the objective. It slides through the two $^3/_4$-in. collars of the frame and mercury prism case, to which it is rigidly attached by set screws after adjustment is made.

The objective, screw-mounted to one end of the collimator tube, is of the two-glass, cemented type, 57 mm in diameter, and in the present instrument has a focal length of approximately 18 in. The lens is well corrected for spherical and chromatic aberration. A double-aperture light stop is mounted inside the collimator tube, close to the objective lens, to reduce extra surface reflections from the prism case and lens surfaces.

At the eyepiece end of the collimator tube, a screw cap accommodates both a sliding draw tube for the filar eyepiece and a tube containing the lamp and the cross scale. The eyepiece can be focused on the movable wire and scale to fit the eye of the individual observer. One revolution of the adjustable drumhead moves the horizontal wire 1 mm across the field of view, giving direct readings to 0.01 mm, equivalent to about 1.1 sec of arc of rotation for the instrument.

The light housing consists of a tube 1 in. in diameter that screws into the telescope cap. To this light tube is screwed an extension tube of smaller diameter that extends down into the collimator tube and contains a clamp on its lower end for holding the red filter. A 3-w, 6–8-v lamp is fitted horizontally into the end of the light tube, with its bayonet base mounted to a slotted spring-tension base contact at the side of the tube. A knurled tension ring screws over this base on the outside of the tube and holds the lamp base and light cord securely in place. Immediately below the lamp, inside the light tube, is mounted a glass disk held between adjusting rings. This disk contains the clear cross centered in an opaque black field. The screw cap on the light tube has a silvered reflector on its inner surface to reflect and concentrate the rays from the lamp upon the cross image, thereby improving the lighting efficiency. After assembly and adjustment is complete, the whole lighting unit is held in position by a steel set screw.

MERCURY CASE IS WELDED STEEL

The mercury prism case is made of welded steel and is constructed in the form of a right-angled hollow wedge about 2 in. wide. Joints are welded together at the corners, and the whole is welded to the under side of a heavy circular steel plate. A rectangular hole is cut out of the center of the circular plate to accommodate a piece of commercial plate glass. To one side of this plate glass is mounted the $1^1/_4$-in. unsilvered right-angled prism, with Canada balsam used as the cementing agency. The plate glass, with prism attached to the under side, is set in the grooved edges of the rectangular opening and is firmly held in place by narrow steel strips attached by screws. Blotting paper is used as a shock insulator and sealer between the strips and the glass. This arrangement provides practically a hermetically sealed mercury container.

Every precaution is taken to provide clean mercury for the prism case. Both mechanical and chemical means are employed in the cleansing in order to insure the necessary clean reflective surface on the mercury and clean surfaces on the glass of the case cover. To form a rigid unit with the telescope, the circular steel-plate top of the mercury prism case is rigidly mounted to the under side of the prism cell cap by means of two sets of opposing screws.

Portable tiltmeters are generally set up on foundation areas or in galleries of dams close to holes that are being grouted. Two instruments are generally used, set up on axes approximately perpendicular to each other, with at least one of the meters oriented parallel to the direction in which the greatest movement is expected. With the two level vials as a guide, leveling up of the tiltmeters is accomplished by first sliding the three sleeves to approximately the level position of the instruments and then completing the finer adjustment of bringing the level bubbles to their respective centers, by rotating the level screws in the proper direction. If the tiltmeters are in adjustment when leveling is completed, the light crosses will be coincident at the center of the scale, and this position (5.00 on the scale) will then constitute the initial reading of a series.

READING OF ONE MILLIMETER MAY INDICATE DANGER

Readings and notations of any tilting are made periodically during grouting operations and assembled with other grouting data. If a definite separation of the images is noted, it is watched closely to detect the amplitude of the final indicated movement. Observations with tiltmeters during grouting operations on shale have shown danger points reached (near rupture of rock) when separation of the crosses was slightly in excess of 1 mm, while a smaller indicated angle of tilt may be critical for other rock conditions. A wide separation of the crosses may require reduction of grouting pressures or, in extreme cases, the termination of grouting operations in certain areas.

New Sewage Treatment Plant at Anderson, Ind.

Biochemical Installation Abates Pollution of White River

By B. A. Poole, Assoc. M. Am. Soc. C.E.

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Unpleasant as it may seem to the consumer, re-use of contaminated water for domestic purposes—after appropriate treatment—is a widely accepted fact. Every expenditure for sewage treatment, therefore, marks a particularly welcome step toward reclaiming the original purity and attractiveness of our natural streams. In the present article, originally given before the Sanitary Engineering Division at the Society's Fall Meeting in Cincinnati, Mr. Poole describes in considerable detail the modern equipment of a carefully designed plant, involving relatively new principles, and discusses various aspects of initial operation experience.

One of Indiana's most important streams is the White River, which rises in the central and southeastern part of the state and flows in a general southwesterly direction to its confluence with the Wabash at Mount Carmel, Ill. Its total drainage area is 11,155 sq miles. The drainage area of the West Fork is 5,284 sq miles, 1,190 of which are above Indianapolis, and 380 above Anderson. Flows as low as 36 mgd have been recorded at Indianapolis.

While the West Fork has extensive recreational and agricultural uses, its chief use is as a source of water supply. The cities of Muncie, Anderson, and Indianapolis, with their estimated 1940 combined population of 484,500, obtain water from this stream. In addition to carrying the domestic sewage of its tributary population, it has been used extensively as a means of disposal of industrial waste, chiefly of an organic nature. It is readily seen that the health and welfare of many people depend directly on its proper use.

Pollution abatement along the upper reaches of the White River has been considered for many years. The first sanitary investigation was made in 1906 by R. L. Sackett, M. Am. Soc. C.E., of Purdue University and the Indiana State Board of Health. This survey covered the section from Winchester to Martinsville. Subsequent surveys were made in 1913, 1925–1926, 1930, and 1937. During this period sewage treatment plants were built at Winchester, Kuhner Packing Plant of Muncie, Tipton, Fort Benjamin Harrison, Sunnyside, and Indianapolis. However, not until 1939 did Muncie and Anderson inaugurate construction of sewage treatment works. The completion of these plants brings the clean-up of the West Fork of the White River above Indianapolis into its final stages. Additional treatment works are now in some stage of construction or active development at Pendleton and Elwood, leaving Sheridan, Alexandria, and Lapel (1940 estimated combined population of 7,900) as the only sources of untreated domestic sewage above Martinsville. Progress has also been made in the treatment of industrial waste, although minor problems of this nature still exist.

Comminutors, Detritor, and Chlorine Unloading Station Are on This Side of the Plant

Although construction of the Anderson treatment works was not started until 1939, the city of Anderson has had this project under consideration for approximately 15 years. Both activated sludge and trickling filter methods were considered in reports prepared during that period.

The main features of the Anderson treatment project are: (1) intercepting sewers, paralleling in general the West Fork of the White River throughout the city—approximately 3 miles in length; (2) main pumping station and approximately 0.5 mile of force main, with comminutors and grit-removal facilities located at the pumping station; and (3) treatment works of the biochemical type.

The intercepting sewer was designed for a total flow of 28 mgd, approximately 3.5 times the present dry-weather flow. The capacity of the pumping station is limited by the size of the 30-in. force main which connects it to the main treatment works. With present pumping equipment the capacity of this line is about 16 mgd. The treatment works proper were designed for an average dry-weather flow of 8 mgd. In this design it was anticipated that storm flows up to 16 mgd could be given primary treatment, and that approximately 12 mgd could be given complete treatment. The sludge equipment was designed to handle not only the sewage sludge but also the city's ground garbage.

View of the Control Building from the Digester

Interceptors vary in size from 18 in. to 54 in. in diameter. Reinforced concrete pipe was used throughout except at the three river crossings. All work was in open cut, and labor was furnished by the Work Projects Administration. Inasmuch as a considerable portion of this sewer is below the low-water level of the White River, a substantially watertight rubber gasket was used on all joints.

(1) Primary Settling Tanks—Sludge Digester and Gas Holder at Left and Rear, (2) One of Two Final Settling Tanks, (3) Effluent from Primary Settlers, (4) Aeration Tanks, (5) Centrifugal Blowers for Aeration Tanks

Major items of the pumping station are enumerated here in the order in which the sewage reaches them (Fig. 1):

Two 25-in. comminutors receive sewage from the 54-in. interceptor. They are designed to handle 10 mgd each, with a maximum loss of head of $17^1/_2$ in.

A grit chamber or detritor follows the comminutor chamber. It is 25 ft square and has an 11-ft maximum water depth. At a flow of 8 mgd this unit provides approximately 10 minutes' retention with a velocity of about 2.5 ft per min. Washed grit is delivered to a storage hopper of 10 cu yd capacity, while organic material is returned to the incoming sewage.

Four vertical, motor-driven pumps deliver the sewage to the force main which connects the pumping station and the treatment works. The capacities of the pumps against a 46-ft dynamic head are 2,000, 3,500, and two at 5,000 gal per min. The operating sequence is such that one of the 5,000-gal per min pumps is a spare.

As stated earlier, a 30-in. force main, also of reinforced concrete, connects the pumping station to the treatment works, which are approximately 0.5 mile downstream. Its limited capacity necessitates the discharge of storm flows to the river when they exceed twice the dry-weather flow. However, the main trunk sewer is connected to the interceptor only a short distance upstream from the pumping station, and well below the built-up section of the city; so it is not anticipated that this procedure will cause the stream any material damage.

In the treatment plant, which employs the biochemical or Guggenheim process, the sewage first enters the primary sedimentation tanks—dual-lane rectangular primary tanks each 106 ft long and 20 ft wide (each lane) with a 10-ft water depth. At flows of 8 mgd these tanks provide approximately 2 hours' retention. Mechanism is available for the removal of scum and sludge. The effluent enters a Parshall flume designed to measure as much as 12 mgd. This Parshall flume discharges into a mixing flume equipped with perforated pipe diffusers. Chemicals, return sludge, vacuum filtrate, and supernatant liquor from the sludge thickener enter this flume.

Two spiral-flow, dual-pass aeration tanks, 108 ft long and 22 ft wide (each lane), with a 10.5-ft water depth, provide a retention of 1.95 hours at 8 mgd, with 15% return sludge. Air is taken from metered 10-in. headers to tubes of the swing diffuser type.

Air is supplied by four centrifugal blowers each having a capacity of 1,000 cu ft per min at $5^1/_4$-lb pressure. All blowers are driven by 40-hp electric motors. At a flow of 8 mgd, plus 15% return sludge, these blowers will provide approximately 0.63 cu ft of air per gal. Air that enters the blowers is cleaned through a 4,000-cu ft per min self-cleaning plate filter and a renewable bag-type filter. These units operate in series.

Mixed liquor is settled in two final settling tanks which are 90 ft in diameter and have a water depth of 8 ft. At a flow of 8 mgd plus 15% return sludge, they provide a retention period of approximately 2.27 hours and a surface rate of 722 gal per sq ft per day. Effluent from these tanks is conducted to the river through approximately 300 ft of 36-in. pipe.

Chlorine may be applied to the raw sewage, to the effluent from the aeration tanks, or to the plant effluent, through either of two 500-lb-per-day vacuum chlorinators. One of these may also be used in the preparation of chlorinated copperas. Chlorine will be delivered in one-ton containers by truck transport, and will be stored in a separate room, with the four cylinders in use being held in another room on two recording platform scales.

Sludge from the secondary settling tanks is pumped to a sludge control tank in the main building by three

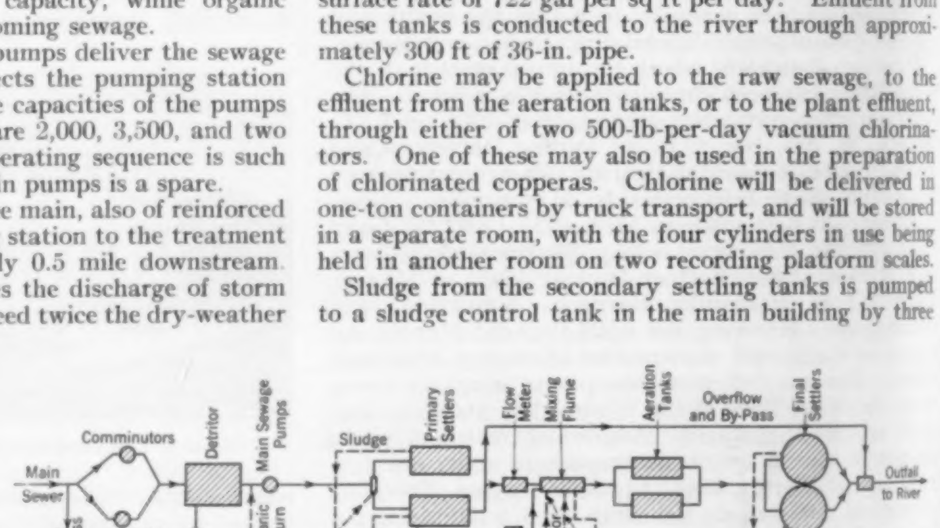

Fig. 1. Flow Diagram for Anderson Sewage Treatment Plant

(1) Chlorinating Machine, (2) Sludge Pumps Handle 650 gpm Each, (3) Vacuum Filters Produce Sludc Cake, (4) Sludge Cake Is Consumed in Incinerator, (5) Abandoned Quarry to Which Ash Is Sluice

variable-speed, horizontal-shaft return sludge pumps rated at 650 gal per min each. The arrangement is such that two pumps are connected to each of the final settling tanks. Excess sludge flows to a sludge thickener of approximately 31,000-gal capacity. Supernatant liquor from the thickener is returned through the mixing flume to the aeration tanks. Primary-tank sludge and scum, as well as sludge and scum from the thickener, are transferred to a single digester by means of three variable-speed horizontal-shaft pumps which have a capacity of from 25 to 125 gal per min.

Partial digestion of the sludge is obtained in a tank 65 ft in diameter and 22 ft deep at the side walls. The small total capacity of the unit explains the fact that digestion is incomplete. The unit is heated and is equipped with a floating cover. It is so constructed that ground garbage may be added to it directly.

Digester gas is transferred to a cylindrical pressure-type gas holder whose capacity is 22,000 cu ft at 50-lb pressure. The gas is utilized to heat the building and digester and to aid in the incineration of sludge.

Sludge flows by gravity from the digester to a sludge elevator. Sludge from the primary settlers and the sludge thickener may also be pumped direct to the sludge elevator, which discharges to a sludge conditioning tank equipped for mechanical agitation. Lime and ferric chloride are used for conditioning. The elevator and feeders are float-controlled in order to maintain a predetermined level in the filter compartment.

Filtration is effected by two vacuum filters which are 8 ft in diameter and 8 ft long and have a total filtering area of approximately 400 sq ft. Filter cake is discharged to the top of the incinerator. A conveying mechanism is now being installed to conduct excess filter cake to a truck or loading platform outside the building.

An 8-hearth incinerator receives filter cake and converts it to ash, which is sluiced to an abandoned stone quarry located on the plant grounds. This incinerator is rated at 60 to 65 tons per 24 hours when handling a cake containing 70% moisture and having a volatile solids content of 60%. Oil is used as an auxiliary fuel in addition to the excess sludge gas. The abandoned quarry previously mentioned as a sludge and ash lagoon has a capacity of about 116,000 cu ft.

The control building is T-shaped in plan and covers an area of approximately 5,600 sq ft. It is constructed of reinforced-concrete and glass-block panels and is three stories in height, two above ground and one below. In addition to housing the blowers, sludge pumps, chlorinators, incincerator, vacuum filters, and sludge conditioning tanks it contains chemical feed equipment, chemical storage space, offices, laboratory, and miscellaneous equipment. A laboratory equipped for both chemical and bacteriological work is available.

Intercepting sewers were constructed with WPA labor at a total cost of approximately $560,000. Of this amount about $266,000 was the city's share, the remainder being contributed by the Work Projects Administration. The sewage treatment plant was constructed with PWA assistance at a total cost of approximately $515,000, of which approximately $285,000 was furnished by the city.

Anderson, with a 1940 population of 41,485, contains several small industries and the relatively large works of the Delco Remy Corporation, devoted to the manufacture of automotive parts. However, this plant discharges only sanitary sewage and small quantities of industrial waste. Major industrial wastes reaching the sewage works originate in a vegetable packing plant, a meat packing plant, a clay tile works, a small steel mill, and a lamp manufacturing plant. The steel mill and the lamp plant are responsible for the relatively large quantities of iron in the raw sewage. Chromates are also present in the wastes from the latter.

Until recently the clay tile works has been the source of much inorganic suspended matter, which not only created a problem in the sewer system but also complicated sludge disposal. However, that material has now been excluded from the city's sewers.

The city is sewered on the combined plan. The Dewey Street 96-in. trunk sewer has its beginning in an open ditch in the southwest section of Anderson. There is a certain amount of flow in this ditch even during dry weather. It is estimated that this flow, together with infiltration in the Dewey Street trunk, accounts for 2 to 3 mgd of additional water. While this affords dilution and thereby reduces the organic strength of the Anderson sewage, it probably contributes to the inorganic suspended matter and increases pumping charges in addition to occupying space in the treatment works. Tentative plans for the construction of a Dewey Street sanitary trunk sewer were made at the same time as the plans for the treatment plant, and were approved by the Indiana State Board of Health.

A study of Table I will make evident the peculiar characteristics of the Anderson sewage. It is particularly interesting that the B.O.D.'s are lower, and the suspended solids higher, than average. The high iron content of the raw sewage is also noticeable. Chromates, while not shown in the tables, are present in quantities varying from zero to 50 ppm (24-hour composite) when the lamp manufacturing plant is in operation.

The plant was put in operation on June 6, 1940. During the first months of operation a number of minor operating difficulties were experienced which are somewhat characteristic of the tune-up period at any sewage treatment plant. However, an epidemic of water-

OUTFALL FROM THE TREATMENT PLANT

borne gastro-enteritis which occurred among sewage plant employees may be classed as an unusual operating difficulty. This epidemic was traced to contamination of the well water supply as a result of a broken sewage line and a broken sludge line. Presumably, sewage entered the well through rock fissures which were developed

TABLE I. AVERAGE OPERATING CHARACTERISTICS

Flows, Detention Time, Air and Iron Applied

				Detention Time, Hours			Settling Rate, Final Settlers		
Month	Flow Mgd	% Ret. Sludge	Mixed Liquor Mgd	Primary Settlers	Aeration Tanks	Final Settlers	Gal per Sq Ft per 24 Hr	Air Cu Ft per Gal	Fe Ppm
June	4.42	19.5	5.28	3.6	3.4	4.7	416	0.62	4.3
July	5.47	14.6	6.27	2.9	2.9	3.3	494	0.46	3.3
Aug.	7.52	16.6	8.77	2.1	2.1	2.4	702	0.45	3.4
Sept.	6.75	18.3	7.99	2.49	2.25	2.62	626	0.45	4.2
Oct.	6.75	17.9	7.93	2.4	2.4	2.9	625	0.46	4.8
Nov.	7.13	16.4	8.28	2.1	2.3	2.7	650	0.43	4.0
Dec.	7.26	15.7	8.40	2.1	2.3	2.6	658	0.51	4.4
Jan.	7.36	16.5	8.57	2.0	2.2	2.6	670	0.53	4.9
Feb.	7.12	17.1	8.34	2.1	2.2	2.5	654	0.34	4.6

Dissolved Oxygen Data and Reduction in B.O.D.

	5-Day B.O.D., Ppm			Reduction of B.O.D., %			Dissolved Oxygen, Ppm	
Month	Raw	Settled	Plant Effluent	Primary Settlers	Aerators and Final Settlers	Plant	Aerator Effluent	Plant Effluent
June	152	62	11	59.1	82.2	92.7	5.1	5.6
July	167	56	6	66.5	89.3	96.4	4.6	4.5
Aug.	175	82	11.5	53.1	86.0	93.5	1.8	2.5
Sept.	175	48	12	72.5	75.0	93.2	3.2	2.3
Oct.	122	45	14	63.0	68.9	88.5	3.3	1.9
Nov.	96	44	20	54.3	54.5	79.2	4.1	3.0
Dec.	103	66	20	36.0	69.8	80.5	2.8	4.3
Jan.	114	59	21	48.3	64.5	81.5	3.2	4.8
Feb.	148	48	25	67.5	48.0	83.2	3.2	4.2

Suspended Solids and Iron Reductions

	Suspended Solids, Ppm				Reduction in Suspended Solids, %		Total Iron, Ppm		
Month	Raw	Settled	Plant Effluent	Mixed Liquor	Primary Settlers	Plant	Raw	Settled	Plant Effluent
June	323	75	13	1,038	76.7	96	...	...	...
July	569	113	6	1,625	80.2	99.1	11.5	6.1	1.0
Aug.	484	116	21	1,660	76.0	95.7	11.8	4.7	2.6
Sept.	667	85	37	1,883	87.2	94.5	24.5	5.9	4.4
Oct.	307	72	37	1,526	76.5	88.0	17.5	8.4	6.3
Nov.	286	76	64	1,940	73.5	77.6	12.5	6.1	7.7
Dec.	235	126	57	2,045	46.5	75.7	12.3	8.8	8.1
Jan.	227	78	48	1,632	65.6	79.0	11.0	5.9	7.8
Feb.	360	57	58	965	84.1	84.0	...	...	...

by blasting during construction. The well has since been recased to a greater depth but it is not yet back in service as a source of drinking water.

The physical appearance of the effluent is not always as good as the laboratory results indicate. While it has many of the characteristics of the activated-sludge plant effluent, it is decidedly yellowish brown in color. This discoloration is noticeable for some distance downstream from the outfall.

WHITE RIVER IMMEDIATELY BELOW OUTFALL

A sludge of unusually low volatile solids content is indicated by Table II. This has resulted in an increased cost of operation at the incinerator and a decrease in output.

The cost data shown in Table III may not be representative of normal plant operation because of experimentation and interruptions which are incidental to the first few months of operation at any plant. Actual plant operation did not begin until June 6 although plant personnel were on the payroll for the entire month. No sludge was filtered and incinerated during June or July but there was considerable experimenting with air and iron dosages during that period. The high inorganic content of the sludge cake was unexpected and is undoubtedly responsible for throwing the sludge handling costs out of balance with similar installations.

TABLE II. SLUDGE DATA AT ANDERSON SEWAGE TREATMENT PLANT

	Total Solids, %		Volatile Solids, %	
Month	Sludge to Filter	Filter Cake	Sludge to Filter	Filter Cake
August	5.4	29.5	48.0	42.1
September	6.8	29.2	38.0	35.7
October	6.0	28.6	41.8	36.7
November	4.7	27.6	44.5	35.2
December	4.8	28.4	48.0	43.7
January	5.0	28.3	49.3	40.3
February	4.8	29.1	46.6	40.5

TABLE III. COSTS OF TREATMENT, PER MILLION GALLONS

			Chemicals			
Month	Salaries and Labor	Power*	Treatment of Sewage	Sludge Conditioning	Fuel Oil	Total
June	$13.37	$11.28	$2.24	....	....	$26.89
July	8.70	8.20	1.36	....	....	18.26
August	9.90	8.05	1.37	$3.62	$2.24	25.18
September	12.10	7.95	1.67	3.98	3.10	28.80
October	11.04	8.10	1.89	3.21	3.74	27.98
November	11.06	7.50	1.72	3.49	3.48	27.25
December	9.55	7.90	1.84	3.42	2.77	25.38
January	8.75	8.04	2.05	4.83	2.91	26.58
February	9.50	7.21	1.95	4.40	2.72	25.78

*Includes pumping of sewage.

Acknowledgement is due to P. J. Kleiser and M. A. Milling, Sanitary Engineers with the Bureau of Sanitary Engineering, for assistance in the preparation of the tables and many helpful suggestions in the preparation of this paper.

Precise Alinement by Sag-Wire and Optical Methods

By Carl I. Aslakson, M. Am. Soc. C.E.

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Inside the new naval towing basin at Carderock, Md., accurate alinement was required for the 1,300-ft rails to support the model carriage. The regular sag-wire method was tested, as well as the optical method of night observations using a theodolite and alinement lights. Both gave accuracies of about 0.2 mm. A later refinement by sag wire reduced the error to 0.05 mm. Among other interesting details, Mr. Aslakson tells of successful observations on out-of-focus light targets.

In recent years numerous scientific studies of minute movements of large structures have been made. In general these studies require accurate determination of both the horizontal and vertical changes in location of various points on the structures in relation to certain points outside them, which are assumed to remain fixed. These studies are particularly important in connection with large concrete dams. Large dams place a tremendous additional load on the earth's crust, not only because of their mass, but also because of their water loads. Frequently temperature extremes add to the static stresses. Movements of various orders must take place in the structures and as a consequence precise alinement, a little-explored field of surveying, is becoming a necessity.

By precise alinement is meant a process such that the probable error will be of an order many times smaller than that ordinarily attained by transit or wire methods. This discussion will be restricted to the precise alinement of intermediate points between two fixed points a limited distance apart—in this case, 1,300 ft. Applicability of the method where greater distances are involved will be considered later.

In the summer of 1939, I had the privilege of assisting in a problem in precision alinement at the David W. Taylor Model Basin of the U.S. Navy at Carderock, Md. The purpose was to establish intermediate points at approximately 40-ft intervals between two points 1,300 ft distant from each other. The line lay along a wall inside the towing basin structure and was to be used to control the alinement of the steel rail on which the driving wheels of the model towing carriage were to run. Since elimination of all sources of irregular motion was of paramount importance, the ultimate in accuracy of alinement was desired.

Two methods were employed: one, designated the "sag-wire method," was used by the physicists of the U.S. Navy; the other, which will be called the "optical method," was employed by the writer. A discussion of these methods, their agreement, and their relative merits and applications, will interest engineers.

At first thought, it might seem that the establishment of a straight line from a sag wire should prove an easy problem. Unfortunately, a number of practical difficulties arise. In the first place, there is a large catenary in a wire 1,300 ft in length. At the model basin a piano wire with an area of 0.000806 sq in. was employed, and although this was stretched until it was under a tension of 186,000 lb per sq in., it still had a $4^{1}/_{2}$ ft catenary sag. Obviously there was also the problem of accurate plumbing from this wire. Certain other practical difficulties were encountered. In a line of that length, absolute freedom from air currents is necessary. The question also arose as to whether or not a magnetic bow might not exist. It was because of this latter uncertainty that a check on the alinement by the optical method was desired.

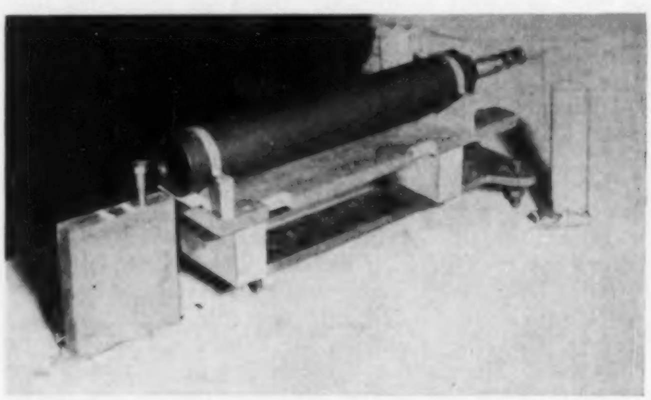
In the sag-wire method, the piano wire was fastened to the wall near one end of the line; at the other end it passed over a pully and was loaded with a 150-lb lead weight. Near the end points the wire was about 7 ft above the wall, while at the mid-point it was about $2^{1}/_{2}$ ft above.

Vertical steel posts $1^{1}/_{4}$ in. by $5^{1}/_{2}$ in. in cross section protruded from the concrete wall about 6 in. at approximately 8-ft intervals. Every fifth post contained a $^{1}/_{2}$-in. brass plug with a polished head set flush with its top. Each plug was set by transit so that the precise line would fall somewhere on it.

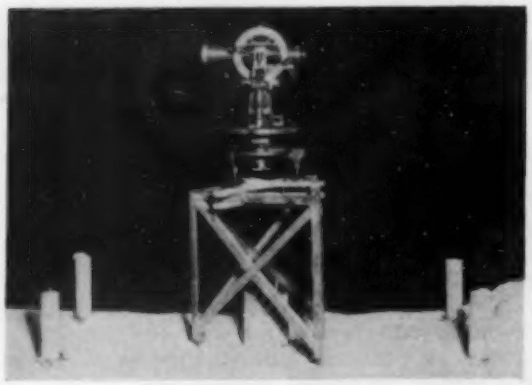
The method of plumbing (Fig. 1) was the unusual feature of the sag-wire method. A small brass plumb bob was suspended by a fine silk thread from the wire. The silk thread was looped over the wire to prevent eccentricity. The plumb bob hung down past one end of the steel post and was immersed in water to damp its movements. A 12-power telescope was placed on line on an adjoining post 8 ft away.

The line upon which the telescope was placed was also established by careful plumbing from the piano wire. The telescope contained a glass diaphragm with an etched scale upon which the position of the plumb-bob thread could be read to 0.02 mm. A sharp stylus was lined in on the brass bolt at the reading of the thread on the telescope scale.

Obviously the approximate method of establishing the telescope on line introduces no serious error. Since the ratio of the distances of the plumb thread and the telescope to the brass bolt is 2 in. to 8 ft, it is apparent that only $^{1}/_{48}$ of the error of alinement of the telescope can enter into the results. Roughly, an error of 1 mm in alining the telescope will affect the established line about 0.02 mm.



Twelve-Power Telescope Set Upon Line, Sag-Wire Method Near the Objective Is Seen $1^{1}/_{4}$ by $5^{1}/_{2}$-In. Steel Post, in Its Top a Bolt, Used in Vertical Control



THEODOLITE AND STAND FOR OPTICAL METHOD

The fact that the scale could be read to 0.01 mm must not give the impression that a series of readings would give a value of that accuracy or less. The image of the thread itself covered many times that amount on the scale and it was necessary to estimate the location of its center. Furthermore, the thread was never absolutely quiet, so that a large number of readings were required to obtain a representative mean thread position. Results obtained over a period of several months indicated that under the ideal conditions obtainable in the basin room, with freedom from air currents, direct sunlight, and sudden temperature changes, the sag-wire method should give a probable error of alinement of approximately ±0.2 mm, provided that at least two sets of observations are made on each point.

The optical method of alinement required the use of two specially designed lights, a steel stand, and a Parkhurst first-order theodolite with a 50-power telescope. The arrangement and use of the equipment is clearly indicated by the photographs.

Originally the lights were designed by Lt. Comdr. E. W. Sylvester, (C.C.) U.S.N., officer-in-charge of installation of the rails, and later were somewhat modified by the writer. A sheet-metal face covered the box of the ordinary flash-type light used by the U.S. Coast and Geodetic Survey. Light issued through a slit about 0.5 mm in width. The inside back of the light-box was painted white. Thus the light viewed by the observer did not come directly from the two 6-v bulbs near the front, but was reflected from the white background. A fiducial edge, arranged in a slide so that it could be raised, lowered, and clamped in position, was provided at the base of the light slit. Thus along this fiducial edge a mark could be made that was in a vertical line with the center of the light slit.

The light was mounted on a lathe cross-feed so that it could be moved back and forth across the line. A micrometer was then placed for recording the relative position of the light slit to 0.01 mm. The whole was arranged to clamp on the steel posts on which the alinement was being made. The clamp screws also served for leveling. A universal level attached to the side of the light indicated when the light-box was level, with an error of about 2 minutes. Since the maximum distance of the fiducial edge from the nearest end of the light slit was only about 15 mm, the probable plumbing error was about ±0.01 mm.

To secure the greatest possible accuracy in the final result, the various sources of error were considered:

1. No system of observing will eliminate errors caused by faulty plumbing of the theodolite. However, repeat observations from stations at opposite ends of the line, or from the same station but with different set-ups, gave some idea of such errors. The plumb bob was carefully tested by spinning and the position of its point was always examined through a reading glass. It was believed that the plumbing error was of the order of ±0.1 mm. Its effect is decreased in proportion to the distance: if the initial light is at the opposite end of the line and a point in the middle of the line is being observed, the effect of the error of plumbing the instrument is reduced by half.

Errors of plumbing the lights were without doubt of somewhat smaller order than those of plumbing the telescopes. This was proved by repeatedly setting the light to a mark with a reading glass and then reading the micrometer.

2. Errors caused by faulty leveling of the theodolite were negligible. A plate level with a value of 10 seconds was used and it was always kept in very careful adjustment. Since the instrument set-up was very rigid, no trouble was encountered in maintaining the level. With one of the observed points 400 ft distant, with the plate out of level by as much as one full division (the maximum was about $^1/_4$ to $^1/_2$ division), and with the maximum vertical angle of 1° between lights, the horizontal error of the point observed upon would be only 0.004 mm.

The error caused by faulty leveling of the light has been shown to be of the order of about ±0.01 mm.

3. Errors caused by horizontal refraction were not serious. All observing was done between 4:30 p.m. and midnight. No workmen were in the building and all doors were closed; there were practically no cross currents of air. On a large percentage of the observations the nearer light was shielded to prevent refraction while the pointing was being made on the initial light. Without doubt, a part of the spread of observations is chargeable to refraction rather than to accidental errors of pointing, but it is believed that such errors were of the compensating type, since there were never any constant air currents across the line of sight.

4. The method of observing was such that accidental and personal errors of pointing tended to be eliminated.

5. Similarly, the method of observing eliminated collimation errors. A single set of observations consisted of 20 made on the initial light and 20 on the alinement light, according to the following procedure:

a) With the telescope direct and the alinement light moved off line several millimeters to the south of the line, the telescope was pointed on the initial light and clamped, and the alinement light was moved slowly in a northerly direction by the lightkeeper, guided by flashlight signals from the observer. When the observer gave the "O.K." signal, the lightkeeper read and recorded the micrometer reading. This process was repeated five times.

b) Next the alinement light was moved successively to the north and five more sets of readings were obtained.

c) Now the telescope was plunged, the instrument was reversed, and five pointings each were likewise made from north and south. Thus personal errors due to the direction of movement of the light tended to be

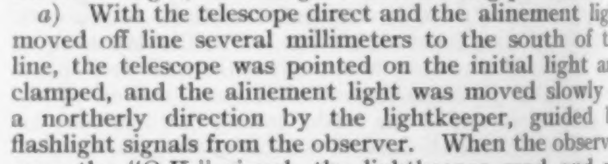
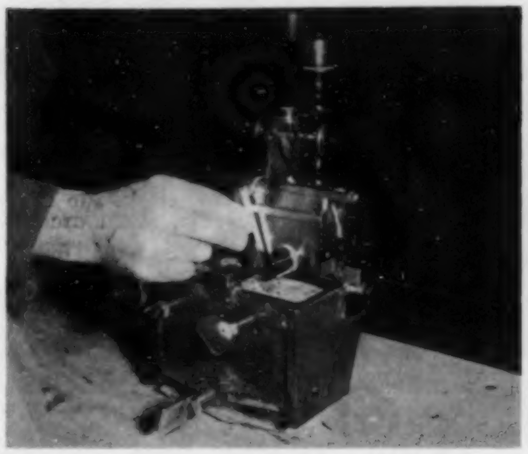


FIG. 1. REGULAR SET-UP FOR PLUMBING FROM SAG WIRE

eliminated, and accidental errors of pointing tended to compensate. Collimation errors also were eliminated by reversing. Since all readings were made and recorded by the lightkeeper, the observer was unprejudiced at all times.

6. Errors due to changing focus were likewise eliminated. At first it was planned to accomplish this simply by not changing the focus between the pointing on the two lights. The theodolite had a sufficient depth of focus so that objects at 1,300 ft and those at 650 ft both appeared clear without changing the slide. After setting the closest point that could be determined without changing focus, it was planned to use that as an initial point in establishing others closer to the instrument. The undesirable feature of this method was the necessity of continually changing the initial light, thus running the risk of accumulating errors due to its faulty plumbing.



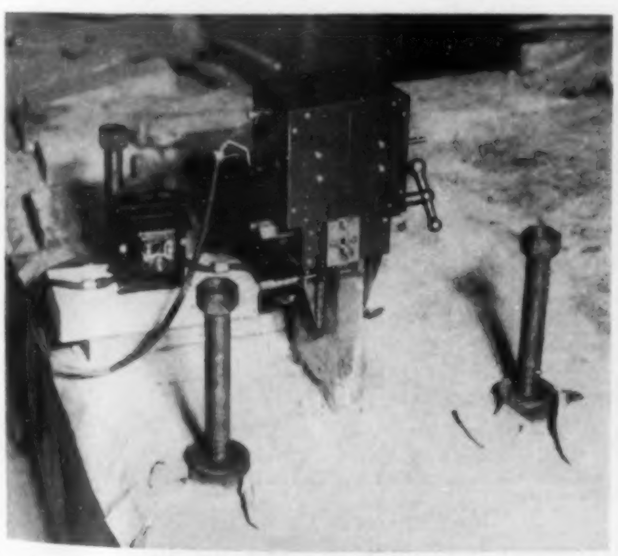
Improved Sag-Wire Method—Instrument Set Up for Locating and Scribing Track Center Lines on Steel Posts

Reference Is Made Through Attached Microscope to Offset Alinement Wire

It was therefore decided to repeat some of the observations with the nearer or lining light out of focus. Surprisingly, this was found to afford an excellent target—the center appeared as a narrow, black line with a diffraction pattern of white light on each side. The resulting observations were very uniform, and generally better than those with both lights in focus. The mean values of the point as obtained by either method checked well, thus proving that no errors caused by optical illusions resulted from observing on a light out of focus. An additional advantage lay in the fact that the line of sight to the initial light passed some distance above the light being alined, thus avoiding the area of heated air directly above.

Theodolite set-ups were made only at the two end points of the line, about 1,300 ft apart. A total of 28 points were observed upon, and repeat observations were made on 9 of them.

A complete report entitled "Optical Alinement at the David W. Taylor Model Basin" was submitted by the writer to the Director of the U.S. Coast and Geodetic Survey. A summary of its conclusions may be of interest.



Special Micrometer-Read Light, Set Up on Steel Post

Regarding applicability, the sag-wire method is extremely limited. The conditions at Carderock, however, were ideal since a complete freedom of air currents is necessary. Under such conditions the method is excellent; the probable error of alinement was of the order of ±0.2 mm as against about ±0.2 to ±0.3 mm with the optical method. On the other hand, the optical method is not limited to use within enclosed structures. Probably a greater number of projects requiring alinement of high accuracy are located in the open, precluding all possibility of using the sag-wire method.

Again, the sag-wire method is definitely limited as to length of line. It is doubtful whether it would prove successful over a distance much greater than 1,300 ft. The optical method, on the other hand, is useful over lines of indefinite extent, as a system for line extension can be developed with little loss in accuracy.

Subsequent to the work described, an improved method of sag-wire alinement was developed by the model basin staff to give a final alinement accuracy of the order of ±0.05 mm. The following description of this method has been furnished by Lt. Comdr. Sylvester. A lower alinement wire was supported a few inches from the steel alinement posts by tangent screw clamps on the posts. This lower wire was brought into the plane of the sag wire by using a phosphor-bronze plumb line suspended from a portable tower. The suspension point of the plumb line was moved laterally by a fine-thread screw toward the overhead sag wire. Indication of contact (or incipient contact) of the plumb line was the lighting of a light in a relay circuit, which was coupled to the contact circuit by a vacuum-tube amplifier. The lower alinement wire was then moved by tangent screws on its supporting bracket into similar contact (or incipient contact) with the plumb line.

A multiplicity of supports along the length of the lower alinement wire was provided to reduce sag in this lower wire, so that a constant-focus microscope, mounted on an adjustable slide with a 1-in. range of movement vertically, could be used to view the wire. This instrument could be accurately adjusted in position on the alinement posts. A vertical fiducial surface, integral with the adjustable microscope holder, was provided at a fixed offset from the axis of the microscope. When the index mark in the field of the microscope was brought into coincidence with the side of the image of the lower wire, center-line marks could be accurately scribed on the post, as shown in one of the photographs.

These scribed lines, of course, were not exactly uniform in width. Those edges of the lines which were coincident with the fiducial surface when scribed were used as the track center-lines. The method, according to Lt. Comdr. Sylvester, was most expeditious.

Further development of procedure and instruments for the optical method may increase its accuracy considerably. For this reason and in view of its wide application, it will doubtless be more generally employed in future.

Road Work in Theaters of Military Operations

Part I. General Considerations—the Task and the Tools

By Stuart C. Godfrey, M. Am. Soc. C.E.

Colonel, Corps of Engineers; Chief, Operations and Training Section, Office of the Chief of Engineers, Washington, D.C.

In continuing the series of articles on the engineering aspects of military work, the Chief of Engineers has made available three papers dealing with present-day problems of road construction and repair under combat conditions. In the first of these Colonel Godfrey points out how responsibility for the bulk of heavy maintenance has had to be shifted away from advance engineer units to units more centralized under army jurisdiction. With the greater mobility of the combatant forces, it is expected that division and corps engineers will move too rapidly to accomplish many permanent or time-consuming road missions. Revisions of engineer unit organization and equipment have been the natural consequence of these changed conditions. Much of the material in this article was presented by Colonel Godfrey at the Society's Spring Meeting held in Baltimore, Md.

Mere numbers avail little in war. Only as men and supplies can be moved to the vital point at the vital moment can an army win victories. In this essential movement of war, roads play, and have always played, an important part.

Recalling that the defense of Verdun in 1916 was absolutely dependent upon the supplies received over a single highway from Bar-le-Duc, we are not surprised that to Frenchmen this road became known as the *Voie Sacrée*. Indeed, none of us who saw service in France can ever forget the roads in the Meuse-Argonne area—that system of once fine highways worn and pounded to pieces by years of incessant traffic and shelling, roads patched and repaired by the labor of thousands of troops, using the masonry from demolished buildings of a hundred villages, roads jammed with trucks and automobiles while weary doughboys slogged by in the mud. Some 70% of the activity of the engineers in the A.E.F. was devoted to road work.

Today, with the advent of mechanization and motorization, and the resulting increased speed of military movements, roads assume an even greater importance. The success of the German Army in Poland, involving a very rapid advance, would have been impossible without the assistance of large numbers of motorized engineer troops. These did an outstanding job in improving the inferior roads, removing obstacles to the advance, and replacing destroyed bridges. In the Lowlands and in France, the Germans found, on the other hand, an excellent system of roads, and the noteworthy performance of their engineers on routes of communication lay largely in the rapid bridging of the many streams that blocked their advance.

On the other side of the ledger, of course, in contrast to the constructive road work, is the complementary engineer task of impeding enemy advance, particularly of blocking the advance of motorized and mechanized forces. Motor transport, for all its potential mobility, is highly sensitive to the demolition and obstruction of routes of communication. An effective defense will make great use of obstacles, both natural and artificial. The latter will include road blocks, demolitions, ditches, abbatis—and particularly mine fields. The removal of such obstacles naturally falls to the opposing engineers who are assisting in the advance, and adds to the difficulties of road work at the front.

In discussing the organization, training, and equipment of engineer troops, let us consider first the military engineer's concept of the road job in an active theater of operations. We are not here concerned with a long-stabilized situation, or with work in quiet rear areas. In such cases, military road work may approach civil practice, and be correspondingly patterned—it may, in fact, under some conditions be turned over to civilian organizations. But for our present purpose assume an active combat area, a fairly adequate road net, and a rapidly moving campaign.

Under these conditions, the military engineer sees his road problem essentially as just another job, for which considerations of ordinary civil road practice give way to the tactical requirements of the moment—involving the scheme of maneuver, enemy reaction, shell fire and bombing, but most of all the time element. New construction, obviously, has little place under such conditions. Here and there may be indicated a road-widening job, a turn-around, a short cross-connection. But essentially the task is one of repair and maintenance. Man power is assumed to be available, but heavy equipment may not be able to get forward. Nor may road materials, bulky in tonnage, be accessible for the moment. The solution is likely to call for expedients, local materials, hand tools—and, above all, speed. Time is always a vital element. The commanding general may demand quick results, verging on the impossible. The hasty solution

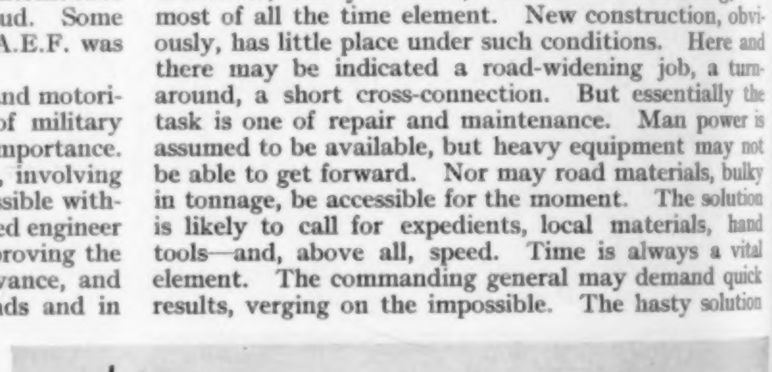


Photo by U.S. Army Signal Corps

Road Repair in A.E.F. Days

315th Engineers at Fay-en-Haye, France, Use Stone from Demolished Buildings—Note Absence of Power Equipment

evolved may be far from the soundest procedure—yet the military commander is the master to be served. The military engineer has to do something right now to get the guns and trucks forward—and perhaps gamble on its being good enough.

ANSWERS NOT IN BOOKS

Hence the military engineer, while he must know roads and road techniques, must not be wedded to ordinarily sound practices. More important for him than highly specialized knowledge are good judgment, common sense, the willingness to take risks. Generally he

Photo by U.S. Army Signal Corps

Today's Troops Have Road Machines

Bulldozer Used to Widen Access Road During First Army Maneuvers, 1940

will not find the answer in any book, but will have to consult his own resourcefulness. Some of the considerations that loom large in the military engineer's concept, as taught him by experience, are as follows:

1. "Road work is always drainage, and then drainage, and then some more drainage. If the water is gotten away from a road, it can be made to serve with almost any materials and under almost any traffic. If water stands on or around a road, it is likely to fail, no matter of what material it is made." (Col. Ernest Graves in *The Military Engineer*, March-April, 1920.) This is as true as when written, and is demonstrated afresh at maneuvers whenever a few days of heavy rain convert secondary roads into quagmires that threaten to nullify all the efforts of streamlined divisions to go places.

2. Good organization for road work often necessitates working men in small detachments. Splitting up the units involves difficulties of administration, but develops self-reliance and resourcefulness on the part of officers, non-commissioned officers, and even privates.

3. At times, as during spring thaws, traffic must be kept off certain roads, if they are to be prevented from failing. The engineer is not charged with the regulation of traffic, but his recommendations as to traffic circulation and control are of importance to the whole command.

4. At other times, the effort to keep roads open may necessitate assistance from infantry and other line troops as labor. Engineers must therefore be prepared to supervise the work of other troops.

5. Width of roads is an important consideration. For two-way convoy traffic, with its heavy wear on shoulders, a minimum width of 18 ft is essential; 20 ft or more is desirable. For narrower roads, the engineer should recommend one-way traffic.

6. The tonnage of road material required for continued maintenance under army traffic is likely to assume enormous proportions. Engineers in the A.E.F. placed

Photo by U.S. Army Signal Corps

Drainage Is of First Importance

1st Engineers near Breyes, France, May 2, 1918

some 300,000 tons of road material before the Armistice, and a much greater amount afterward. The French used no less than 17,000,000 tons during the World War.

7. Consequently, the transportation of road material demands provision for many trucks, preferably dump trucks. There is never enough transportation in war to meet all demands. In the World War the British specified that every fifth truck going forward should carry road material.

Existing general engineer units include the "combat battalion" with the triangular divisions, the "combat regiments (corps)," the "general service regiments," and the "separate battalions." Their organizations are designed to suit the differing demands of the larger military units they serve. The matter may be further clarified by reference to Table I of General Schley's paper, "Rôle of the Engineers in Warfare," in Civil Engineering for January 1941.

Division Engineer Battalions. With the increased emphasis on its combat functions, the mission of this battalion in a rapid advance must be limited to the simplest tasks of clearing the route of obstacles, the initial crossing of small streams, and similar missions. Road work in general must be left for succeeding echelons of engineer troops. The unit has three tractors with bulldozers (angle-dozers) of $7^1/_2$-ton weight, one per company; also three air compressors, with jackhammers, pavement-breakers, saws, and other items. It is completely motorized, that is, it has sufficient trucks organically assigned to move its personnel and equipment. National Guard divisions retain the "square" organization, with four infantry regiments, and a "combat regiment" as the engineer component.

Corps Engineers. Each army corps of three divisions contains two "combat regiments" of engineers. These units, with more men and equipment, are better qualified for road work than the divisional units, and as such will often be charged with road tasks. However, tactical missions, such as the protection of the flanks by barriers, are likely to interfere with their very effective and continuous employment on roads.

Each corps regiment has two small gasoline shovels ($^3/_8$-yd and $^1/_2$-yd) and a motorized grader, in addition to bulldozers and air compressors. The $^3/_8$-yd gasoline shovel was selected on considerations of weight—it can traverse our light bridges. The regiment is motorized, very much so, with no less than 101 dump trucks of $1^1/_2$ tons each (which are utilized as personnel carriers and as general-purpose vehicles).

Army Engineers. Allotted to the normal field army of three army corps are three "general service regiments." These units, assisted by the labor of six "separate bat-

Photo by U.S. Army Signal Corps

HAND WORK STILL PLAYS IMPORTANT RÔLE

Engineers Widen a Road with Stone Fill, First Army Maneuvers

talions," constitute the basic organizations for road work in an army area. They comprise some 11,000 men and operate under the Army Engineer, who is charged with all roads in the army area. The general service regiment has somewhat more and heavier equipment than the corps combat regiment. The separate battalion has relatively little power equipment. Neither unit is completely motorized.

General engineer troops with a normal field army thus have organically assigned to them a fairly large amount of engineer and motor equipment, as indicated in Table I.

TABLE I. PARTIAL LIST OF ROAD-BUILDING EQUIPMENT IN A FIELD ARMY

EQUIPMENT	9* DIV. BNS.	6 CORPS REGTS.	3 G.S. REGTS.	6 SEP. BNS.	2 DUMP TRUCK COS.	TOTALS
Bulldozers	27	48	24	48	..	147
Air compressors, motorized	27	48	24	30	..	129
Gasoline shovels, $^{3}/_{4}$-yd	..	6	..	..	..	6
Gasoline shovels, $^{1}/_{2}$-yd	..	6	6	6	..	18
Road graders, motorized	..	6	6	6	..	18
Dump trucks, $1^{1}/_{2}$-ton	477	606	123	102	90	1,398
(Other trucks omitted)						

* This assumes an army composed entirely of triangular or "streamlined" divisions. If some of the old "square" divisions are grouped with the triangular divisions, however, the figures will not be materially different.

This equipment is actually in the hands of our troops, or being furnished as new troop units are organized. The prompt receipt of it has enabled our engineer units, many of them at new cantonments, to be of great service in connection with the road and general construction work incident to occupation of the areas.

PREPARATORY AND TRAINING MEASURES

During the past twenty years, our small engineer troop component of some 5,000 men has had little specialized training in road work. An exception to this occurred in Panama and Hawaii, where the 11th and 3d Engineer Combat Regiments have executed extensive improvements in macadam, asphalt, and other types of road and trail construction. (See "New Military Roads and Trails in Oahu" by Col. Robert S. Thomas, M. Am. Soc. C.E., CIVIL ENGINEERING, June 1938, and "Road Building in Panama," by the writer in *The Military Engineer*, January-February 1938.) But in the continental United States, with the small nucleus of troops available, efforts have necessarily been concentrated largely on basic engineer and combat training (plus the specialized work of the topographic battalions, which obviously could not be quickly formed in an emergency). Until recently little money could be made available for road machinery and power equipment other than experimental units. This situation could be accepted with less reluctance because of the knowledge that standard road equipment could be quickly procured; and in view of constant improvements, large stocks of such equipment were not necessary or desirable under conditions then existing.

Today all this is changed! The Army faces an emergency demanding readiness for action. Moreover, ample funds have been made available. The little component of engineer troops is undergoing a rapid fifteen-fold expansion, from 5,000 to 75,000 men—by summer. These units represent all types of engineer troops, including aviation engineers—a new unit especially organized to build, maintain, and defend landing fields for the Air Force. All these units, as they are organized, are being well equipped. Aviation units in particular are supplied with such special machines as sheepsfoot rollers, road material mixers, bituminous material distributors, scrapers, rooters, shovels, and graders.

The preceding description refers to troop units and the equipment with which each is organically supplied. In addition to this, plans provide for special road and construction equipment to be stocked in army depots for issue to troops when needed.

In this category will be included such items as portable rock crushers, road rollers of various types, bituminous mixers, scrapers, spreaders, sweepers, harrows, and the like. Decision has been made, after experimentation, as to the appropriate types and numbers of these items to be provided at this time, and their procurement is now being effected. This equipment will be issued for test and training to four general service regiments (one in each of our field armies) which are being organized this spring and summer.

NEW ROAD UNITS NOT PLANNED AT THIS TIME

The organization of special road troops is not contemplated, at least at this time. Such troop units may prove desirable for specific needs, in some future development—and in that case would doubtless be composed largely of highway engineers and crews. The 23d Engineers was in fact organized during the World War as a special road regiment. But it is considered desirable to avoid the formation of special units unless the need is clearly indicated. In a sense, all general engineer troops are road units. However, it is planned to add to

Photo by U.S. Army Signal Corps

ARMY ROADBUILDERS IN PANAMA

Twenty Miles of Jungle Defense Roads Constructed and Maintained by the 11th Engineers

the list of units now authorized for a field army an "equipment company," charged with caring for the equipment assigned to army depot stocks, as distinguished from organizational equipment. For some types of equipment its personnel will include skilled operators who will accompany their machines when issued. It is further contemplated that this equipment company, together with the depot company, shop company, and dump-truck companies already authorized for a type army, will be grouped for administration and control into a "park battalion."

In the activities of our expanded army, moreover, every advantage will be taken of opportunities to train engineer troops in road work. Such opportunities will never be lacking, to be sure, especially where new cantonments are springing up. But in addition to these contributions to cantonment construction and improvement, and to the varied training afforded at maneuvers, special attention will be paid to training under assumed tactical situations, and to testing the special equipment issued to our new general-service regiments. Extensive practice will be had with various road techniques developed in modern highway practice, including possible adaptations of soil stabilization for military use and especially the applicability of bituminous materials for the rapid repair of military roads. Incidentally, the Engineer School at Fort Belvoir gives successive three months' courses for large classes of enlisted specialists in the operation and care of all types of engineer equipment.

Initiative and Resourcefulness Exhibited

That our existing engineer units are alive to the importance of road work and training is evidenced by reports such as a recent one from the 15th Engineer Battalion at Fort Bragg. This unit, just organized last fall, has devised a novel type of corduroy mat, wired together and rolled for transportation into cylindrical sections. These sections can be rapidly unrolled and fastened together to form a hasty roadway over swampy ground that is adequate for the passage of tanks.

Another typical illustration of the resourcefulness of engineer troops confronted with road problems is furnished in a commendation by the Commanding General, V Army Corps, as follows. The 107th Engineer Regiment is the engineer component of the 32d National Guard Division, which was inducted in Michigan and moved to Camp Beauregard, La., last October.

"I desire to commend the 107th Engineers for the excellent work it has done in keeping traffic moving and in constructing under great difficulties roads necessary for the training of its division. . . . During the short period, January 8 to 10, 1941, the 107th Engineers reconstructed about 3/4 mile of new road, the greater part of which was impassable; it improved about 8 miles of third-class roads which contained many bad sections, some of which were impassable; and it worked on bad sections in 3 1/2 miles of additional roads. Throughout these operations it kept necessary traffic moving by use of tow line and tractor or truck when necessary. In carrying out this difficult task, the 107th Engineers showed courage, initiative and ingenuity, skill in the handling of its equipment, knowledge and appreciation of its duties as combat engineers, and, above all, excellent esprit de corps in the interest and determination it displayed in accomplishing its task and in playing its part in carrying out the mission of its divison.

"This work was excellent practical training in the duties of the regiment in war."

Photo by U.S. Army Signal Corps

Bituminous Road Construction in Hawaii

Photo by U.S. Army Signal Corps

A Hasty Corduroy Road

Devised by the 15th Engineers at Fort Bragg, This "Pavement" Can Be Rolled Up and Put Away

The Engineer Reserve officers being ordered by the hundreds to active duty include many who are experienced in road work, and whose special training will be of value—has already been of value—in all these activities. Among the selectees, also, who are assigned to engineer troops, will be many who have had previous experience in road work.

In this connection, special mention should be made of the helpful contribution of the American Society of Civil Engineers, through its Special Committee on Military Road Construction and Maintenance, headed by Col. William N. Carey, Engineer Reserve. Organized two years ago, this committee has recently published a partial report on the subject of "Military Roads in Forward Areas," which was reviewed in Civil Engineering for December 1940. The complete report, when published, will constitute a valuable supplement to the chapter on "Roads" in the Engineer Field Manual—a concise description which is not intended to be a comprehensive technical treatise. Colonel Carey has also written, as one in this series of papers, a further discussion, covering some practical and technical aspects of military roads in the theater of operations.

Little mention has been made of bridges. Yet manifestly a road is no stronger than its weakest link, which exists usually at a stream crossing. The Corps of Engineers has given much study to the design of military bridges, both floating and fixed, and to the bridging equipment to be issued to engineer troops. Certain types not previously provided for are now under development. In this connection, the work of the Corps of Engineers' development agency, the Engineer Board at Fort Belvoir, is being supplemented by the work of the National Defense Research Committee. The standard types of fixed bridges now adopted, which are intimately associated with any discussion of roads, will be described in another article of this series.

Sand-Shell Admixture as Flexible Road Base

Texas Highway Department Finds Natural Material from Galveston Bay Reef Plus "Gas Mound" Loam Stands Up Under Asphalt Surface

By E. R. Young *and* R. T. Pinchback, Jr.

Respectively Resident Engineer, and Instrumentman, Texas Highway Department, Liberty, Tex.

Use of admixed sand and shell instead of gravel or untreated shell as an economical road-base material is believed to be a new development in this country. The project on which it was recently used in Liberty County, Tex., consisted of about six miles of road with a flexible base 23 ft wide and a single asphalt surface 22 ft wide. The project is on Highway 146 from the intersection of U.S. 90 to a point about 5 miles south of the city limits of Dayton. Grading and drainage structures on this section were completed in the fall of 1936 and work on the base and surface was begun in January 1940. The project was completed in August of the same year.

SUBBASE OF SANDY LOAM

The roadbed treatment (Texas classification Type B) consisted of 6 in. of compacted "gas mound" sandy loam with shoulders of the same material, which was secured at several points adjacent to the right-of-way. Gas mounds, as they are commonly called, are knolls of fine sandy loam containing from 35 to 130 cu yd of material and are abundant in the Gulf Coast area of Texas. There is a belt of them approximately 20 miles wide and about 15 or 20 miles inland from and parallel to the shore of the Gulf of Mexico.

No serious difficulty was experienced in handling this sand and the cost was not excessive, as one 1/2-yd dragline and six 4-yd dump trucks could handle 100 cu yd or more per hour in a haul of three-quarters of a mile. Compaction was secured with a tamping roller and a pneumatic-tired roller, using the material at the optimum moisture content. Full standard Proctor compaction was secured in this way. The roadbed was then shaped to true section and grade and the unwashed mud shell for the first course of flexible base was applied at the rate of 28 cu yd per station, truck measurement. The shell was obtained from reefs in Galveston Bay. It was unloaded from barge to hopper by a clamshell derrick barge at Cedar Bayou and hauled to the job in 6-yd, side-dump, trailer trucks. The average haul was approximately 17 miles.

First the shell was spread out to a width of 20 ft and allowed to dry for two days. Then followed a period of manipulation with blades and harrows to completely dry it and the soil binder it contained. The material was completely turned over at least twice daily until it became a uniform gray color. The minimum time of manipulation was two days, and the minimum time for drying, four days, depending on weather conditions. After complete drying, and to avoid compaction by construction equipment and traffic, it was left in a windrow until just before the sand admixture was added.

During the period of hauling and drying, the laboratory control work was completed. Six samples were taken from each barge, the weights averaged, and two representative samples sent to the field laboratory. By measuring the overload on several trucks before they left the hopper and remeasuring them at the point of delivery, the shakedown in transit was determined to be approximately 10%. This was added to the hopper weight determined by the sample measurement, and the result was used as the unit weight of the shell on the road.

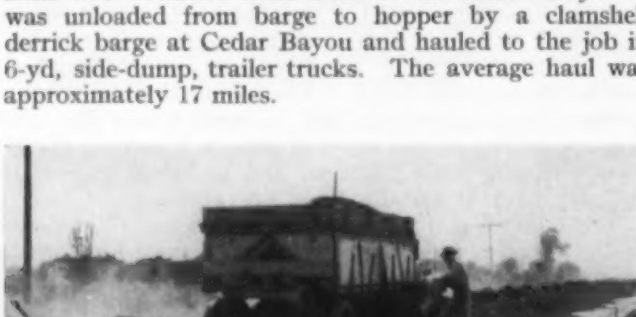
Tests were run on each sample of shell, and the following typical values were obtained:

Wet weight, lb per cu ft	82	Liquid limit	37
H_2O, %	22	Plasticity index	19
Dry weight, lb per cu ft	67	Material passing 40-mesh sieve, %	20

RIDGE SAND ADMIXTURE USED WITH SHELL

On this job the admixture sand used was ordinary ridge sand, of which about 95% passed the 100-mesh sieve and had a plasticity index of 2 or 3. All admixture sand was secured from one source. The average dry loose weight was found to be 75 lb per cu ft.

A series of curves (Fig. 1) was drawn using different percentages of admixture sand and the original soil binder in the shell, soil binder being that portion passing the 40-mesh sieve. This was done on several samples of original shell soil binder ranging in plasticity index from



Mud Shell Hauled Wet from Barge
First Course of Flexible Base Took 28 Cu Yd per Station

Sand Admixture Dumped on Dried Shell
Three Trucks Were Weighed Each Day to Determine Unit Weight

14 to 27. From these data the design of the admixture for each barge of shell was chosen and a trial mix of the original soil binder and admixture sand was made. The constants were then run to see if the admixture would be within the specifications.

The following specifications governed the admixture:

Screen analysis of completed compacted base:
Passing $1^1/_2$-in. screen.................... 90 to 100%
Passing 40-mesh sieve.................... not more than 55%
Material passing 40-mesh sieve (soil binder):
The liquid limit shall not exceed.......... 35
The plasticity index shall not be less than.. 4
nor more than 12
The linear shrinkage shall not exceed...... 7%

(Note: The linear shrinkage shall be calculated from the volumetric shrinkage between the liquid limit and the shrinkage limit.)

The admixture for an average sample of shell would be designed in this manner: Given shell with 20% soil binder and a plasticity index of 19. From the original admixture curves (Fig. 1) find that 70% of admixture sand and 30% of original shell soil binder would give a resulting mixture with a plasticity index of about 6. Therefore, the percentage of soil binder required would be

$$\frac{(70/30)\ (20) + 20}{(70/30)\ (20) + 100} = 45.5\%$$

This design would be well within the specifications with an allowance for the breakdown of the shell under manipulation. A 70–30 proportion of admixture sand and original soil binder was made up and the plasticity index run to check the design.

SPREADING OPERATIONS

The admixture sand was hauled in 3-yd trucks and dumped in the required amount, generally between 7 and 10 cu yd per station, and evenly spread across the full width of the shell. A harrow unit, consisting of a 10-ft spring-tooth harrow and a 10-ft disk, pulled as a unit by a pneumatic-tired farm tractor, was used to mix the sand with the shell. After approximately a half hour of harrowing time per station, blades were used for further mixing. This operation was continued until the dry materials were completely mixed, or segregation began. The material was then spread to the full 23-ft width and the moisture content raised to about 15% in order to slake the original soil binder in the shell. The mixing operation was continued until the original shell soil binder and the admixture sand were thoroughly mingled. The moisture content was then checked and raised or lowered to the optimum.

Next the material was spread and shaped to the required section and rolled with a tamping roller. About a quarter of an hour of rolling time per station was required for each 3-in. compacted course. The base was again shaped and finish-rolled with a pneumatic-tired roller. It was then slush-rolled with a similar pneumatic-tired roller to glaze

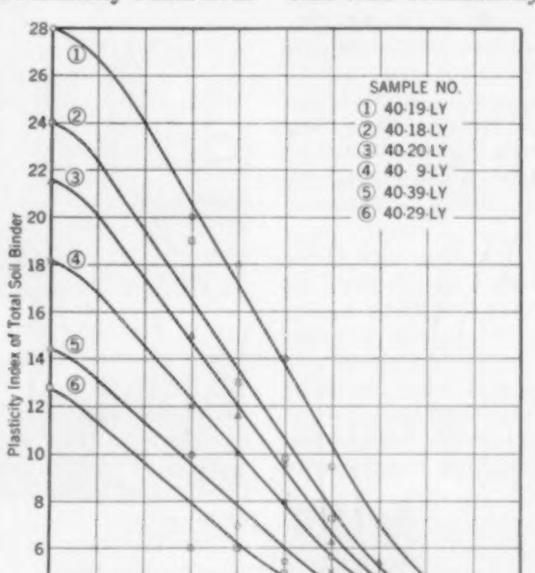


Fig. 1. Design Curves for Proportioning Sand-Shell Admixture

Dry Materials Mixed by Spring-Tooth Harrow

the surface for the purpose of preventing dusting and raveling.

A second course of equal thickness was applied under the same conditions with a resulting final average compact thickness of $6^1/_4$ in. After completion of the base, the shoulders and slopes were built up of the same material used for the roadbed treatment.

The base was then primed with 0.25 gal per sq yd of medium curing cutback asphalt (Texas classification MC-1) obtaining approximately 95% penetration. After 24 hours, a single asphalt surface of $^1/_2$ gal per cu yd of oil asphalt (Texas classification OA-135) and $^3/_8$-in. gravel at 1 cu yd to 75 sq yd, was applied.

COSTS PROVE MODERATE

Costs are presented in the following summary:

Unit	Total Cost	Cost per Sq Yd	Cost per Mile
Preparation of roadbed.......	$ 971.50	......	$ 163.88
Roadbed treatment and shoulders..................	17,227.09	......	2,906.05
Flexible base.................	35,900.43	$0.4395	6,056.08
Prime coat and asphalt surface	8,253.57	0.1055	1,392.30
Totals..................	$62,352.59	$0.5450	$10,518.31

Final results as to plasticity index and soil binder content were consistently uniform, the range of the former being from 6 to 10, and that of the latter from 45 to 55%. Field densities averaged 130 lb per cu ft. It was notable that the shrinkage in volume of the admixed material was only about 30% as compared with 50% for the untreated shell; hence the use of cheap local material makes the cost of this type of base some 15 to 20% less than the cost of an untreated shell base of equivalent width and thickness.

Results on this project have been very gratifying, and apparently an excellent flexible base has been constructed. No failures or soft spots, common in untreated shell bases, have occurred to date, some six months after completion. Haden and Austin, Inc., of Houston, Tex., were the contractors on the work. T. E. Huffman, M. Am. Soc. C.E., was District Engineer for the Texas State Highway Department.

Vertical-Lift Bridge Has Tower Drive

New Increased Minimum Clearance Over Passaic River Reduces Openings from Thirty a Day for Old Swing Span to Five a Day

By Henry C. Tammen, M. Am. Soc. C.E.

and Ellis E. Paul, M. Am. Soc. C.E.

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ALTHOUGH placing the main motors on the lift span affords easier leveling control, in this instance it was found that the tower drive effected economies in cost, improved appearance, and cleaner operation. Tie motors were used for both main and auxiliary operation, and special devices were provided to reduce high current values. Auxiliary motors were permanently connected to the operating machinery to avoid the use of clutches. Special cable-lubricating devices were installed, and numerous safeguards provided for use in the event of equipment failures.

A NEW highway bridge carrying Lincoln Highway, New Jersey State Route 25, over the Passaic River was opened to traffic at 11 p.m., Sunday, January 26, 1941. It replaces an existing bridge which had been in service since 1921, and which was quite inadequate in many respects to carry the increasingly heavy traffic. As truck traffic is not permitted on the Pulaski Skyway nearby, most of the trucks traveling between Manhattan, by way of the Holland and Lincoln tunnels, and south and west New Jersey over U.S. Routes 1 and 22, take this lower road to cross the Passaic and Hackensack rivers. Truck traffic is excessive, and is augmented morning and evening by local traffic caused by the thousands of employees of the adjacent Western Electric and Federal Shipbuilding and Drydock plants.

The bridge provides two 24-ft roadways separated by a 4-ft center island and two 6-ft sidewalks. The river section consists of a through truss vertical lift, 332 ft 6 in. long center to center of end bearings, and two flanking deck plate girder spans each 112 ft long. The approaches are continuous deck plate girder spans about 80 ft long, five such spans being used on the west side of the river and twelve on the east side.

For best approach connections, it was desirable that the new bridge be as near the old one as practicable. It was necessary to maintain traffic over the old bridge and also, in order to avoid interference with navigation on the river, to keep open both channels through the existing swing span. These requirements fixed the center line of the new bridge 95 ft from the old and led to a horizontal clearance of 300 ft between the fenders at the tower piers, more than would normally be required for a bridge at this location.

The new lift span provides a vertical clearance of 40 ft above mean high water when seated on the piers as compared with about 10 ft for the old swing span. This increased clearance is expected to reduce the average daily frequency of span openings from 30 to about 5, and will result in a material reduction in delays to highway traffic. Vertical clearance at full height is 135 ft.

Every effort was made to secure a pleasing appearance consistent with utility and economy. The towers were supported entirely on their piers instead of partially on approach spans. This permitted the use of an economical deck girder structure for the flanking spans and led to the selection of tower piers, each with two separate units, one on each side of the bridge. Each unit was made just large enough to carry a lift-span shoe and the shoes for the four tower columns on one side of the bridge; the girder of the flanking span was supported on the rear inside tower shoe. Each pier unit was founded on rock and had base dimensions of 25 by 40 ft. Above the high-water line, the units were hollow and these spaces were used in part to house transformers and other equipment. Large hollow concrete struts were provided between the units at the tops of the piers, but these served only to provide housing for switchboards and other equipment, and not as pier bracing. These struts are 50 ft long and the pier units are very rigid; hence to avoid objectionable temperature cracks they were not made monolithic with the pier

Lift Span Erected Complete on Falsework

In Background Is Nearly Completed Tower of New Bridge

shafts but were simply supported in slots on the piers and provided with expansion rollers at one end.

The lift span is of Warren truss type with some members of carbon steel and some of silicon steel. All members are of solid section with perforations in plates of box members to give access to the inside for maintenance painting. No lacing was used on the lift span except on the top laterals. Roadways and sidewalks are of light-weight floorings, galvanized open grating for roadways and concrete-filled grating for sidewalks.

Towers are of the same general type used on the Triborough Bridge for the Harlem River Crossing (Civil Engineering, September 1936, page 563). Each tower

Center Span Being Floated Into Position

Tide Was Used to Pick Up Span and to Lower It Onto Pier During Moving

comprises two four-column braced units over the sidewalk areas connected with portals over the roadways and with trusses and girders at the tops of the towers. The major part of the load from lift span and counterweights is carried by the four front columns of each tower, and the towers are cambered to distribute this load equally over the four columns. Provision was made in upper column splices for removal or insertion of shims to care for errors in fabrication and erection in order to be assured of this load distribution, but no such adjustment of splices was found necessary. The four columns of each unit are at the corners of a rectangle measuring 12 by 24 ft.

Two types of drive are in general use for vertical-lift spans, the span drive with the operating machinery on the lift span and the tower drive with the operating machinery at the tops of the towers. The tower drive was preferred for this bridge largely because of the greatly improved appearance of the lift span without the machinery house, operating machinery, and the operating ropes with their drip troughs to protect pedestrians from grease. Detailed studies and cost estimates were made for both methods of operation, and as the tower drive showed a slight saving in cost and also gave a preferred appearance it was adopted. The tower drive resulted in a reduction of 20% in the weight of the lift span, and this reduced weight gave sufficient saving in counterweight ropes, counterweights, balance chains, and other parts to more than offset the large increase in the cost of electrical equipment for the tower drive.

The lift span weighs 1,350 tons and is suspended by 64 plow steel ropes $2^1/_8$ in. in diameter. Sheaves have a pitch diameter of 15 ft, one sheave carrying the 16 ropes at each side of the tower. Each sheave weighs 31 tons. Studies were made for both one and two sheaves on each side of each tower, and the single sheave was adopted to secure simplicity in operating machinery as well as economy. The use of one 16-rope sheave rather than two 8-rope sheaves produced a cost saving of $37,000 without taking into account the saving in structural metal supports.

Special devices were provided for periodical lubrication of the counterweight ropes. These are set on the tower floor and arranged to supply lubricant to the ropes immediately above the floor on the rear sides of the counterweight sheaves. A metal box is provided as a container

Part of Erection Tower Being Assembled by Derrick Boat

for the lubricant. Inside it, two 6-in.-diameter hardwood rollers are mounted on bearings in such a manner that the lower roller is partially submerged in the lubricant while the upper roller moves around the bottom roller during contact with the counterweight ropes. Operation of the span turns the rollers and carries the lubricant to the ropes. This arrangement was

Steel-Grating Deck Was Placed While Span Was in Raised Position

devised by D. J. Henderson, of the State Highway Department maintenance staff, and tried out on another vertical-lift bridge. It was found that by leaving the lubricator in place through a number of span operations very effective lubrication of ropes was secured.

Balance chains consisting of cast-iron links with steel pins are used to overcome the unbalanced load of 44,000 lb produced when the main counterweight ropes pass over the sheave during operation of the span. The weight of the chain is so selected that a true balance is maintained between the span and the counterweight at all positions of travel.

Operation of the lift span is effected with electric motors direct connected to the operating machinery in the towers. For each tower this operating machinery comprises a central herringbone gear reduction unit operating in oil and connected through transverse shafting and through two spur-gear reduction units, one at each side of the tower, to operating pinions which engage racks bolted to the tower sheaves. All motors are connected to the center gear unit by means of flexible couplings. The transverse shaft is connected to the gear units by means of gear-type flexible couplings. The couplings adjacent to the side gear units are made adjustable by special drilling to permit one counterweight sheave on a tower to be rotated with respect to the other sheave when necessary to make the two lift-span shoes at each end of the span seat simultaneously on the piers. This adjustment permits accuracy of seating within 0.01 in.

It is not possible without some trial by addition and removal of blocks to provide counterweight masses so uniformly distributed as to give counterweight loads on the ropes at each corner of the span exactly equal to the lift-span loads. Without such an exact balance between the lift span and the counterweight at each corner, as the span is operated the ropes at each corner will gradually creep over the sheave in the direction of the heavy side. They will continue this creep through successive operations until the weight on the counterweight side exactly balances the weight on the bridge side plus or minus the weight required to warp the span. Such creeping of course means that the span no longer will seat on all four shoes when it is lowered to its piers. To solve this difficulty the adjustable coupling is utilized. Opening up this coupling on the side of the span shoe which is seated, permits the other side of the span to be pulled down with the operating machinery until its shoe is seated, and the adjustable coupling may then again be engaged. Blocks are next removed or added to the counterweights and shifted from one side to the other, by trial, and the operation of the span continued. Usually several trials are necessary before the required balance is obtained, the creeping eliminated, and continued good seating of the span insured.

It was essential that a reliable means be provided for auxiliary operation of the span in the event of failure of the main power line or of any part of the control equip-

Tide Was Used to Pick Up Span and to Lower It Onto Pier During Moving

BOTH TOWERS WITH LIFT SPAN IN HIGH POSITION
Derricks Erecting Machinery Houses in Tower Lofts. Windows in Tower Penthouse Indicate Size of Structure

ment. For a tower drive such auxiliary operation must necessarily be electric in order to synchronize the movements of the ends of the span. Usual practice has been to install a gasoline-engine-driven generator set to furnish this emergency power. In this case a second source of primary power was available, and was made use of at an estimated saving of about $15,000.

Power was obtained from two independent lines of the Public Service Electric and Gas Company, which have a ring of generating and switching stations through New Jersey and Pennsylvania, all tied to their Essex Distributing Station with duplicate indoor and outdoor distributing equipment. From this station, multiple feeder lines are carried to two separate substations, to one of which in addition an emergency tie feeder is conducted. Thus, two independent sources of power are provided with almost complete assurance that one will be available at all times.

The power is 3-phase, 60-cycle, 440-v, alternating current taken from transformer banks in the south shaft of the north tower pier.

Normally the span is operated by two 200-hp driving motors, one on each tower. Synchronization of the travel of the ends of the span is obtained with two 100-hp tie motors. The time required to raise the span to its full height of 95 ft is approximately two minutes. The size of motors was selected so that in case one of the main drive motors is out of service, operation of the span could proceed under normal light-load conditions with only one drive motor, the tie motors serving to transfer torque from the tower having the drive motor in service to the other tower. In case either of the two tie motors is out of service the span must be operated with the auxiliary motors. Power for main motors can be obtained only from the first power line.

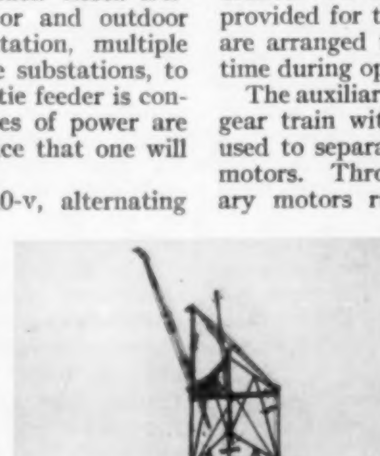
Two 125-hp driving motors and two 75-hp tie motors are provided for auxiliary operation which requires approximately four minutes. The motors were selected so that the span could be operated under average unbalanced load conditions with only one drive motor and two tie motors. In case either of the two tie motors is out of service, the span can be operated with the two driving motors, and is kept in a level position by means of a differential selsyn control system. In case of failure of the latter, the span is kept level by hand equipment that duplicates manually the actions of the selsyns in controlling the motor resistance. Power for auxiliary motors can be obtained from both power sources.

As an added safeguard, skew limit switches have been provided to break the motor circuits and apply all motor brakes when the span is approximately 2 ft out of level. The switches are separate for main and auxiliary operation. If the span has become skewed for any reason, it can be brought back to a level position with a hand "level-up" switch provided on the control desk.

Complete, independent control systems have been installed for main and auxiliary operation. This equipment has been segregated on the control desk and on the switchboard. Twelve spring-set brakes are also available for slowing or stopping the span. These brakes are enclosed in housings as a protection against moisture. All brakes serve for operation with both main and auxiliary motors. As an added precaution, duplicate feeders with transfer switches have been provided for all brakes. All circuits for main control are run in cables and conduits separate from those used for auxiliary control.

Control of the main and auxiliary motors is of the full magnetic type with master switches mounted on the control desk. These switches also control the motor brakes. In addition, a separate controller has been provided for the control of the machinery brakes which are arranged to give a variable braking torque at any time during operation of the span.

The auxiliary motors are directly connected to the main gear train with no clutch or other disengaging means used to separate them from the operation by the main motors. Through a 2:1 ratio in the gearing, the auxiliary motors run without load at twice their normal speed whenever the span is operated with the main motors, and are thus always ready for service. There can be no troubles from failure of clutches and their operating devices. In order that no damage will result to the auxiliary motors, they are provided with special banding which will permit them to operate safely at 250% of synchronous speed and each motor was tested to demonstrate its ability to withstand this over speed.



ERECTION TOWER RAISED TO 122 FT FOR ASSEMBLING BRIDGE TOWER
Jumping the Boom Into the Stiff-Leg Derrick; 70-Ft Boom Used as a Basket Gin Pole

To obtain synchronization of travel of the ends of the span, the connections between the tie motors are governed from the master controller by first applying single-phase power to the tie motor simultaneously with reduced power to the drive motors, and following this by three-phase power to the tie motors. The amount of current required for the single- and three-phase steps depends upon the number of degrees the two tie motors are out of step. These current values may be quite large, and the single-phase currents especially are undesirable. To overcome this condition, electrical devices were furnished to automatically synchronize the tie motors at ap-

proximately 60 deg or less, thus reducing the high current values by more than 50% during these synchronizing periods, with a reduction in the tie motor transfer torque of less than 10%. The sizes of the tie and drive motors and their cables were selected after a complete analysis of different design loading conditions in connection with available motor torques taken from performance curves, and were based on various sizes of cables with lengths to suit this particular application. Special operating tests such as operating the span in both directions under various conditions of balanced and unbalanced loading and with certain motors out of service were carried out with completely satisfactory results.

Kearney Side Tower—Both Sheaves in Place

Limit switches cut power from the motors and apply the motor brakes near each end of travel. Foot-operated push buttons permit operation beyond the cutoff points, but are made inoperative except at low speeds by action of a special speed governor. Another governor controls the operation if the span should overhaul the motors and travel at an excessive speed.

Traffic signals, navigation, airway obstruction and service lights, indicating signals, and other usual features are provided. An intercommunication telephone system has been installed with seven stations located in various houses and rooms in the towers and piers. This was of particular value in making adjustment during the installation and testing of equipment. Manually operated barrier gates are provided and interlocked with the span operation.

Except for the gates, all operations of the span are controlled from the operator's house located just above the sidewalk in the north leg of the west tower. Similar houses are provided in the other tower legs for the use of the gate tenders and for storage. The electrical switchboard, about 40 ft long, is located in the room in the strut between the shafts of the west tower pier. This room has been insulated and equipped with electric heaters and an exhaust fan. Small elevators are provided in each tower for access to the machinery houses.

The towers were each erected with a stiff-leg derrick supported on a triangular tower about 125 ft high resting on the flanking span. The same derricks were used to place tower sheaves, ropes, machinery, and all other equipment on the towers.

To avoid interference with navigation over an extended period, the lift span was floated into position. Permission was granted by the U.S. Engineers to close the channel for a maximum period of 72 hours while this procedure was carried out.

The span was erected on falsework and two barges were floated under it between falsework bents. Then the span was blocked up on triangular timber towers on the barges, and the load was transferred to the barges by the rising tide. The barges were so located that they would clear the old draw protection as the span was floated into position. Only the trusses, floor beams, and lateral and sway bracing were in place at this time, and the weight was about 700 tons.

Connections in Place for Lift Span End Posts (L_0-U_0), Top Chords (U_0-U_1), Portal, and Lifting Girder Erected

Before the span was floated in, the steel counter-weight boxes had been suspended by temporary links from girders at the tops of the towers and partially filled with concrete to give a weight of about 640 tons, or 60 tons less than the weight of the span at the time of floating. The end verticals of the lift span were suspended by lines from the tower columns, the lifting girders were connected to the verticals, and the suspending ropes were placed over the sheaves and connected to the counterweights and to the lifting girders.

The span was floated in slightly above its final position and was blocked up as the load was transferred from the barges to the piers by the falling tide. The end truss verticals and lifting girders were then lowered and the bottoms of the verticals connected to the trusses. By means of jacks at the four corners, the span was then raised from its supports on the piers, the supports were removed, and the span was again lowered until its entire weight was carried by the suspending ropes. The links suspending the counterweights from the tower tops were then removed and the span raised to full height with temporary falls connected to lines leading to hoisting engines located on the decks of the approach spans.

The lift span was completed in the fully raised position, traffic over the old bridge was then discontinued, the swing span was opened and blocked up on its draw protection, and its upper section was removed over several panels to permit the lift span to be lowered for traffic.

The contractors for the work were: substructure, Senior and Palmer; superstructure, except concrete floor slabs, American Bridge Company; concrete floor slabs, LaFera Grecco Contracting Company; and removal of existing substructure, General Contracting and Engineering Company. The bridge was constructed for the New Jersey State Highway Department. Morris Goodkind, M. Am. Soc. C.E., Bridge Engineer, was in general charge of the work, with Albert E. Lee serving as resident engineer in charge of construction for the Department. Ash-Howard-Needles and Tammen (now Howard, Needles, Tammen and Bergendoff) prepared the plans and specifications for the lift-span structure and supervised the erection of the machinery and electrical equipment.

Multiple-Purpose Reservoir Operation

Part I. In Single or Independent Units

By Nicholls W. Bowden, M. Am. Soc. C.E.

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A DECADE ago it was not uncommon to hear, in effect, that provisions for flood control and hydroelectric power production in the same project were incompatible. By way of explanation, engineers usually said that this conflict would be inevitable because the interests of flood control required an empty reservoir ever ready to receive flood water, while the interests of power production required a full reservoir, to provide the maximum of stored water and head. In short, they held that it was futile to attempt to operate a reservoir for multiple purposes.

Coming sometimes from men of outstanding reputation in the field of hydraulics, these opinions created considerable uncertainty in the minds of engineers, especially because there was then little background of experience upon which to base the feasibility of operating reservoirs to serve more than one use. Thus it is perfectly natural that early support of the multiple-purpose reservoir theory was somewhat timid. Yet one might well wonder why, even with the limited experience at that time, it was not suggested that the reservoir be kept half full, or empty in the flood season and full in the dry season, thus satisfying both needs. This simple principle, which results in the allocation of reservoir space to each use, the amount varying perhaps in different seasons of the year, is now the foundation for planning, designing, and operating projects to serve more than one purpose.

While multiple-purpose projects may not yet be generally accepted by the engineering profession as effective for controlling water, their proponents can point with considerable assurance to definite trends in planning and to actual operating records that are favorable to the multiple-purpose theory.

Because of the magnitude of the problem, the necessity for basin-wide treatment, and the many and varied uses of water involved, most of which, such as flood control and navigation, do not produce direct monetary returns, the federal government is the principal agency engaged in the development of water resources. States are becoming interested to some extent, as evidenced by the creation of such agencies as the Grand River Dam Authority in Oklahoma and the Lower Colorado River Authority in Texas, with their large multiple-use projects.

Perhaps 10 or 15 years ago, federal agencies concerned themselves almost entirely with single-purpose projects. This was no doubt largely because of legislative inhibitions and also, perhaps, because of lack of confidence and lack of planning technique for developing multiple-purpose projects. At present all important federal engineering bureaus consider the several uses to which the water may be put in planning and designing control works. Moreover, either in conforming with provisions of new laws or through voluntary agreements, planning of water projects is coordinated among the various agencies to insure exploration of all practicable water uses. In other words, the planning of projects to serve a single purpose without first studying the possibility of serving other needs is being discontinued.

Although we still have much more to learn on the subject, results thus far attained place us in a more fortunate position than a decade ago, when only one of the projects discussed here, Sacandaga Reservoir in the Hudson River basin, was in operation. That reservoir has now been in operation ten years; Tygart Reservoir in West Virginia, more than two years; and the Boulder Canyon Project about six years, during most of which time its reservoir, Lake Mead, was being initially filled. The Tennessee Valley Authority also has eight multiple-purpose projects, but since they are planned for system, rather than for unit, operation, consideration of them will be reserved for a later paper.

Sacandaga Reservoir for the Hudson River Regulating District very successfully blazed the trail for multiple-purpose operation. In a paper in Civil Engineering for November 1938, Edward H. Sargent, M. Am. Soc. C.E., gave extensive information on this project.

The reservoir has a capacity of 760,000 acre-ft, equal to nearly 14 in. of runoff, or about half the average annual runoff on the 1,040 sq miles of the controlled drainage area. The regulation afforded has been very effective. For the largest flood, in March 1936, it reduced the flow at Albany from about 270,000 cu ft per sec, which would have exceeded the largest flood of previous record, by some 50,000 cu ft per sec, a crest reduction of about 4 ft. In addition, incidental power is developed in a plant built and operated by a private company.

Tygart Reservoir serves the Pittsburgh area. In 1930 the upper reaches of the canalized Monongahela almost went dry, several of the pools losing their entire head owing to inadequate stream flow, estimated as low as 5 cu ft per sec. Only by using some 65,000 acre-ft stored in a private Cheat River reservoir was there sufficient flow for leakage and lockage in this heaviest traveled river in the country, which normally carries some 20-odd million tons of commerce annually. Also, the water supply for industrial and domestic uses and for sanitation in this highly industrialized and thickly populated valley would have been inadequate.

The Tygart multiple-use reservoir on a tributary of the Monongahela, about 150 miles above Pittsburgh, not

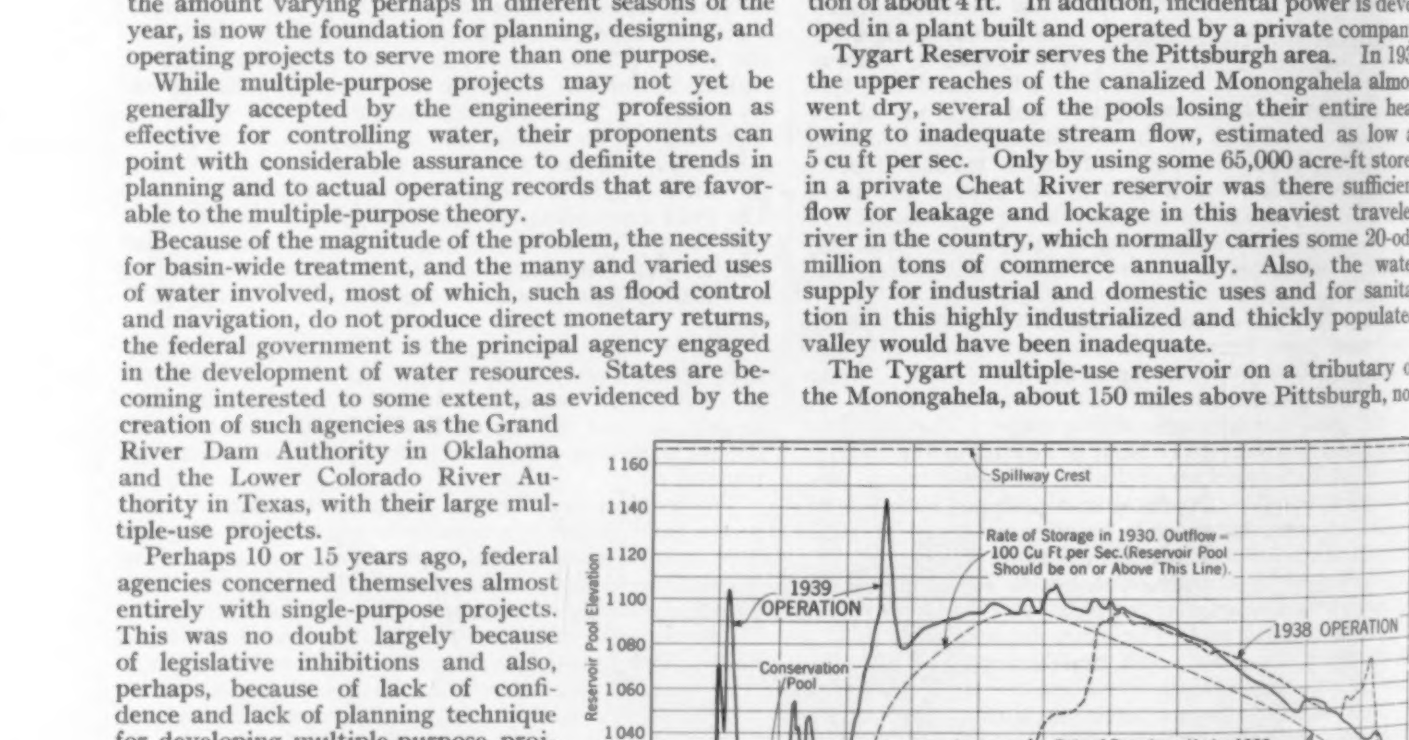

Fig. 1. Chart of Tygart Reservoir Operation

only fills these needs but serves other useful purposes. With a drainage area of about 1,180 sq miles, it has a controlled capacity of about 290,000 acre-ft; all except about 11,000 acre-ft, retained for a conservation pool, is available for flood control from December 15 to April 1 each year. During this period, floods are temporarily held in the reservoir and then released as rapidly as is safe to restore the flood storage space. Beginning early in April, after which time damaging floods are less likely to occur, filling is started (Fig. 1) with a view to impounding 100,000 acre-ft by June 15 for release during the low-flow season in the late summer and fall. The remaining storage space of some 180,000 acre-ft is always available for flood control, as is an additional 87,000 acre-ft of partly controlled storage between spillway crest and top of dam.

Depending on flows in the Monongahela River, the rate of discharge is varied, care being taken to maintain sufficient storage to insure a minimum outflow of 340 cu ft per sec to the end of the low-water season. Following an operating schedule based on flows in the extreme low-flow year of 1930, the level is kept above the filling and emptying guide for that year (Fig. 1). The late impounding of storage in 1938, the first year of operation, was due to delay in adjusting certain flowage items.

Since its completion and up to early in 1940, the reservoir has reduced the crests of five floods on the Ohio River at Pittsburgh an average of about 1 ft, and on the Monongahela River an average of about 3 ft, with resulting benefits estimated at about $3,000,000; it has also maintained adequate flows during the low-water seasons. In 1939 it successfully met a drought situation almost as severe as that of 1930. At times it supplied about 60% of the total discharge of the Monongahela, thus maintaining traffic and greatly improving municipal and industrial water supply. At the end of the low-flow season there still remained in the reservoir sufficient water to permit further releases for a considerable period.

The act providing for the gigantic Boulder Canyon project requires that the reservoir be operated for five major purposes—river regulation and flood control, irrigation, silt control, power development, and domestic water supply. It provides for amortizing the project through the sale of power and water, of which the former is expected to be much the larger item. This means that it is highly desirable to secure the greatest output of power without important loss to either flood control or irrigation. Therefore, the lake should be held as high as practicable, at the same time retaining adequate flood space on top of the power and irrigation storage, for use in spring and early summer.

Lake Mead has a capacity of about $2^1/_2$ times the average annual flow of 11,900,000 acre-ft, of which 9,500,000 has been reserved for flood control. This, together with the total safe release of some 2,500,000 acre-ft during the flood period, is considered ample to take care of flood runoff. For the most efficient use of the flood storage space, forecasts of inflows are necessary. This is a difficult task in a basin of 170,000 sq miles, where elevations range from 1,200 to 12,000 ft, and snowfall, rain, temperature, and wind conditions change frequently.

The operation of Lake Mead to date has been largely the initial filling of the reservoir, as noted by the "stair-step" shape of the filling curve (Fig. 2), indicating the annual cycles of storing to January 1940. The flood storage space is above El. 1155, at which point the storage volume is 21,000,000 acre-ft. The sharp drawdown between January and March 1939 was made to provide adequate storage space in the face of anticipated heavy flood runoff in the spring and early summer.

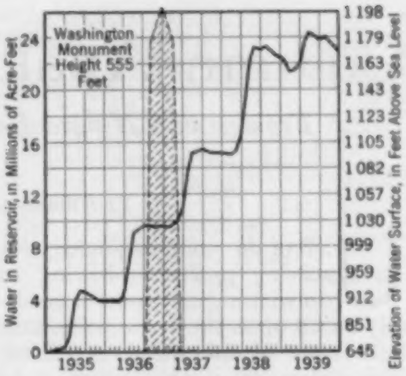

Fig. 2. Storage in Lake Mead, 1935–1939

The runoff, however, did not measure up to expectations and the reservoir lacked some 23 ft of reaching spillway crest, El. 1205.4, before drawdown again began in July.

It is understood that the reservoir water surface will be varied as necessary between about El. 1155 and the spillway crest, El. 1205.4, or even to the top of the spillway crest gates, El. 1221.4, if necessary. Ultimate high-water surface is at El. 1229, about 3 ft below the dam crest. Ordinarily refilling will take place from about March 1 to July 1, when flood flows are being regulated, and drawdown to El. 1155 will be made during the remaining eight months of the year.

During 1936, three power units were put in operation. By the end of 1939, there were nine units, two having been added each year, with the result that revenues increased from about $59,000 in 1936 to nearly $3,500,000 in 1939. Beginning with 1940, annual revenues exceeding $7,000,000 are expected.

Lake Mead regulates the Colorado River so as to provide a dependable all-year water supply for irrigation in the lower basin. The flow no longer varies between such wide limits as 3,000 to 200,000 cu ft per sec but is controlled between about 8,000 and 45,000, thus providing ample water for diversion at all times and decreasing the cost of operation and maintenance of flood protection works from over $500,000 annually to about $50,000. Ultimately about 1,000,000 acre-ft of water will be diverted annually for domestic supplies for 13 cities, including Los Angeles, and this will produce additional revenues toward repaying the cost of Boulder Dam.

Before storage began behind Boulder Dam, the yearly cost to the Imperial Valley Irrigation District alone of keeping its canal clean was about $1,500,000. In 1937, two years after impounding began, the silt load had been reduced at Yuma, Ariz., from about 96,000 acre-ft to about 8,500, with large savings to irrigators in southern California, Arizona, and old Mexico. The silt now in the river at Yuma comes in below Boulder, but desilting works at the Imperial Dam, diversion for the All-American Canal, Yuma, and Gila projects can remove about 80% of this before the water enters these canal systems.

There has been a marked change of opinion recently among American engineers as to the efficacy of multiple-purpose water-control projects and the desirability of constructing them wherever practicable. Even more indicative of the trend is the very great increase in the number of such projects that have been and are being built. This type should continue to grow in popularity especially because of the possibilities of greater total returns than would accrue from a single-purpose project even if more efficient.

The writer sincerely appreciates the cooperation received from the following members of the Society: John C. Page, Commissioner of Reclamation, Washington, D.C.; Edward H. Sargent, Chief Engineer, Board of Hudson River Regulating District, Albany, N.Y.; and Lt. Col. W. E. R. Covell, Corps of Engineers, formerly District Engineer, Pittsburgh, Pa. Without their assistance his data would have been meager.

Column Analogy—Some Special Applications

Frames with Hinged Ends and Continuous Closed Frames Treated in Five Examples

By R. A. Caughey, M. Am. Soc. C.E.

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PROBABLY almost any type of rigid frame can be analyzed with the help of the column analogy if enough simplifying conditions are temporarily introduced. Practically, however, the degree of complication permissible is restricted. In this paper Professor Caughey brings out a few of the simpler extensions of the method to conditions encountered in structural design with considerable frequency. For those who prefer analogous concepts as a guide to analytical procedure, the application given here will be of particular interest.

USE of the column analogy for solving problems having to do with rigid frames is generally based upon the assumption that both ends of the frame are fixed. The objective of this paper is to show how this method may be applied to other end conditions and to the closed frame or closed ring such as a box culvert or pipe culvert, respectively.

The general procedure in using the column analogy may be summarized in four steps:

1. Modify the structure in such a way that a moment diagram for one or more members considered as simply supported beams may be plotted. This may be done by regarding fixed reaction points as hinges, cutting the structure apart, or inserting hinges. Compute the simple beam moments, M.
2. Load a column the width of which at any section is the reciprocal of EI (E = Young's modulus, I = moment of inertia) of the structure under consideration, with a load the intensity of which at the section is the magnitude of the moment at the same section obtained from Step 1.
3. Compute the fiber stresses at given sections of the analogous column of Step 2.
4. Combine the fiber stresses of Step 3 with the original moments of Step 1 to obtain the resultant moments.

(For details, see Bulletin 215, Engineering Experiment Station, University of Illinois, by Hardy Cross, and *Continuous Frames of Reinforced Concrete*, by Hardy Cross and N. D. Morgan.)

The basic working equation of the method is

$$f = \frac{P}{A} + \frac{M_x'}{I_x'}x + \frac{M_y'}{I_y'}y \quad \text{.......(1)}$$

where f is the intensity of stress at a given section of the analogous column, or the indeterminate portion of the final moment at the corresponding section of the beam or frame considered. Other elements of this equation are defined through the following relations:

P = total load on analogous column = $\sum \frac{Ms}{EI}$ (M from Step 1)

A = area of analogous column = $\sum \frac{s}{EI}$

s = length of sections of neutral axis of beam or frame

$$\frac{M_x'}{I_x'} = \left(M_x - M_y\frac{I_{xy}}{I_y}\right) \Big/ \left(I_x - I_{xy}\frac{I_{xy}}{I_y}\right) \quad \text{.......(2)}$$

$$\frac{M_y'}{I_y'} = \left(M_y - M_x\frac{I_{xy}}{I_x}\right) \Big/ \left(I_y - I_{xy}\frac{I_{xy}}{I_x}\right) \quad \text{.......(3)}$$

x, y = coordinates of any point on the axis of the analogous column or frame measured from two perpendicular axes, X-X and Y-Y, which pass through the centroid of the section

I_x = $\int x^2\,dA$ = moment of inertia of section about Y-Y axis

I_y = $\int y^2\,dA$ = moment of inertia of section about X-X axis

I_{xy} = $\int xy\,dA$ = product of inertia of section about axes X-X and Y-Y

M_x = moment of load P applied to analogous column about axis Y-Y

M_y = moment of load P applied to analogous column about axis X-X

To use this method successfully, the question of signs must be handled systematically. By means of a proper system, their determination may be made automatic. The writer recommends the following set of rules:

1. In rigid frames or beams, consider a moment positive when it produces compression on the upper or outer fibers of members, and negative when it produces tension on upper or outer fibers. From this rule we obtain the signs of various portions of the applied moment load on the analogous column and also the final moments in the frame.
2. Positive coordinates are those measured upward or to the right from the origin, and negative coordinates are those measured downward or to the left.

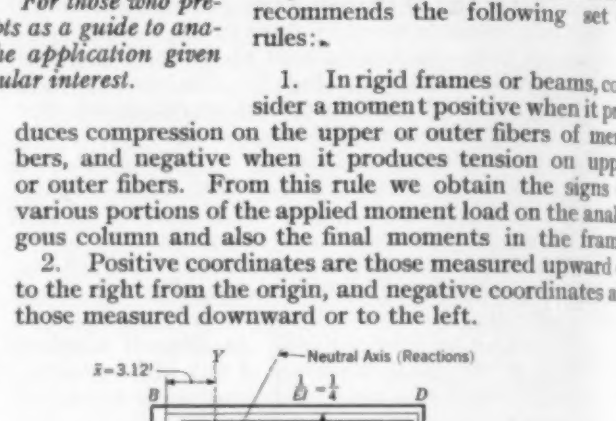

Fig. 1. Frame with Fixed Ends

3. In loading the analogous column, consider positive moment loads (Ms/EI) as acting downward and give them plus signs, and treat negative moment loads in the opposite way.
4. When the sign of unit stress, f, in the analogous column is positive, it is acting upward.
5. To obtain resultant moment at any section of the frame subtract the result of Step 4 from that of Step 3, taking due account of signs.

To illustrate the method, computations covering the determination of moments in the frame of Fig. 1 will be made.

Static moments of areas of portions of the frame about the base give y = 11.46 ft. Moments about center line of column AB give x = 3.12 ft.

I_x (about Y-Y) = 930.67 ft⁴; I_y (about X-X) = 1,119.25 ft⁴

$$I_{xy} = 20(-3.12)(-1.46) + 4.0(+4.88)(+8.54) + \frac{20}{6}(+12.88)(-1.46) = 194.8 \text{ ft}^4$$

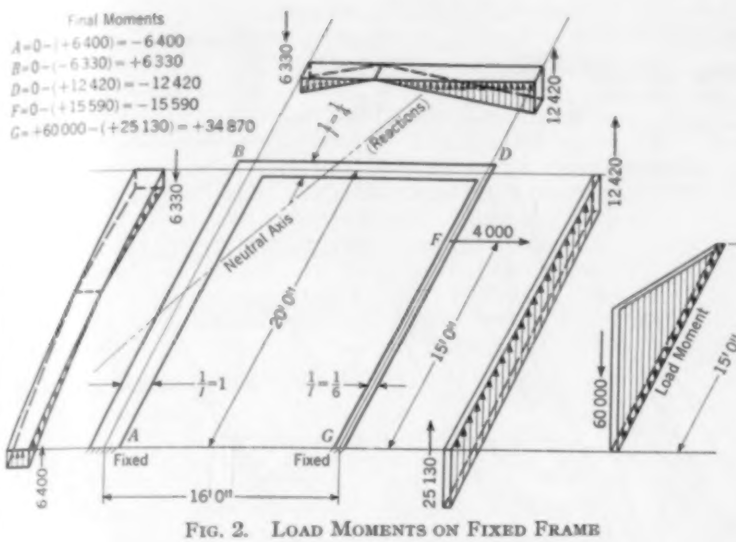

FIG. 2. LOAD MOMENTS ON FIXED FRAME

To secure an Ms/EI loading for the analogous column, the frame will be cut at F (Fig. 1) and the portion (FG) will be regarded as a cantilever beam loaded as shown. The left segment of the structure, $ABDF$, could have been used because it would have been able to carry the horizontal load as a bent cantilever independent of segment FG, but more work would have been involved.

With the analogous column loaded with the "load moment," consisting of a wedge of altitude 60,000 lb-ft, a base length of 15 ft, and a width of 1/6,

$$M_x \text{ (about } Y\text{-}Y) = +75{,}000\,(+12.88) = +966{,}000$$

$$M_y \text{ (about } X\text{-}X) = +75{,}000\,(-6.46) = -484{,}000$$

$$M_x' = M_x - M_y \frac{I_{xy}}{I_y} = +966{,}000 + 484{,}000 \frac{194.8}{1{,}119.25} = +1{,}050{,}000$$

$$M_y' = M_y - M_x \frac{I_{xy}}{I_x} = -484{,}000 - 966{,}000 \frac{194.8}{930.67} = -686{,}000$$

$$I_x' = I_x - I_{xy} \frac{I_{xy}}{I_y} = 930.67 - 194.8 \frac{194.8}{1{,}119.25} = 896.77$$

$$I_y' = I_y - I_{xy} \frac{I_{xy}}{I_x} = 1{,}119.25 - 194.8 \frac{194.8}{930.67} = 1{,}078.55$$

$$\frac{P}{A} = \frac{75{,}000}{27.33} = 2{,}750$$

Since at the neutral axis of the resultant stresses f is zero, the general equation for the axis from Eq. 1 becomes

$$\frac{P}{A} + \frac{M_x'}{I_x'}x + \frac{M_y'}{I_y'}y = 0$$

If x and y in turn are placed equal to zero, the intercepts of the neutral axis on the Y-Y and X-X axis become

$$y_1 = -\frac{P}{A} \bigg/ \frac{M_y'}{I_y'} \text{ and } x_1 = -\frac{P}{A} \bigg/ \frac{M_x'}{I_x'} \quad \ldots\ldots\ldots (4)$$

Substituting proper values in Eq. 4 we have, for this particular problem, $x_1 = -2.34$ ft and $y_1 = +4.32$ ft. These values are plotted in Fig. 1. From Eq. 1, fiber stresses are:

$$\text{At } A, \frac{P}{A} + \frac{M_x'}{I_x'}x + \frac{M_y'}{I_y'}y = \frac{75{,}000}{27.33} + \frac{1{,}050{,}000}{896.77}(-3.12) + \frac{(-686{,}000)}{1{,}078.55}(-11.46) = +6{,}400$$

$$\text{At } B, \frac{75{,}000}{27.33} + \frac{1{,}050{,}000}{896.77}(-3.12) + \frac{(-686{,}000)(+8.54)}{1{,}078.55} = -6{,}330$$

$$\text{At } D, \frac{75{,}000}{27.33} + \frac{1{,}050{,}000}{896.77}(+12.88) + \frac{(-686{,}000)(+8.54)}{1{,}078.55} = +12{,}420$$

$$\text{At } F, 2{,}750 + \frac{1{,}050{,}000}{896.77}(+12.88) + \frac{(-686{,}000)(+3.54)}{1{,}078.55} = +15{,}590$$

$$\text{At } G, 2{,}750 + \frac{1{,}050{,}000}{896.77}(+12.88) + \frac{(-686{,}000)(-11.46)}{1{,}078.55} = +25{,}130$$

In accordance with the rule, the resultant moments at various points in the frame are, at A, $0 - (+6{,}400) = -6{,}400$; at B, $0 - (-6{,}330) = +6{,}330$; at D, $0 - (+12{,}420) = -12{,}420$; at F, $0 - (+15{,}590) = -15{,}590$; and at G, $+60{,}000 - (25{,}130) = +34{,}870$. The values of applied moment loads and reactions on the analogous column are plotted in Fig. 2.

In Fig. 3 is shown the same frame illustrated in Figs. 1 and 2, except that the end connection G is hinged instead of fixed. In order to carry the load on a determinate structure, cut the frame under the point F and remove the portion FG. Figure 3 shows the moment curves for the various members between A and F.

Since $1/EI$ at the hinge is infinity, the X-X and Y-Y axes will pass through hinge G as shown, P/A will become zero, and Eq. 1 will become

$$f = \frac{M_x'}{I_x'}x + \frac{M_y'}{I_y'}y \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$I_x \text{ (about } Y\text{-}Y) = \frac{20\,(1)^3}{12} + 20\,(16)^2 + \frac{0.25\,(16)^3}{12} + 16\,(0.25)\,(8)^2 = 5{,}463.0 \text{ ft}^4$$

$$I_y \text{ (about } X\text{-}X) = \frac{(20)^3}{3} + \frac{16\,(0.25)^3}{12} + 16\,(0.25)\,(20)^2 + \frac{0.167\,(20)^3}{3} = 4{,}711.13 \text{ ft}^4$$

$$I_{xy} = 20\,(-16)\,(+10) + 4\,(-8)\,(+20) = 3{,}840$$

$$M_x \text{ (about } Y\text{-}Y) = -450{,}000\,(-16) + 50{,}000\,(-16) + 80{,}000\,(-8) = +5{,}760{,}000$$

$$M_y \text{ (about } X\text{-}X) = -450{,}000\,(5)\,(50{,}000)\,(18.33) + 8{,}333\,(18.33) + 80{,}000\,(20) = +419{,}243$$

$$M_x' = M_x - M_y \frac{I_{xy}}{I_y} = +5{,}760{,}000 - 419.243 \frac{(-3{,}840)}{4{,}711} = +6{,}101{,}800$$

$$M_y' = M_y - M_x \frac{I_{xy}}{I_x} = +419{,}243 - 5{,}760{,}000 \frac{(-3{,}840)}{5{,}463} = +4{,}469{,}243$$

$$I_x' = I_x - \frac{(I_{xy})^2}{I_y} = +5{,}463 - \frac{(3{,}840)^2}{4{,}711} = +2{,}323$$

$$I_y' = I_y - \frac{(I_{xy})^2}{I_x} = +4{,}711 - \frac{(3{,}840)^2}{5{,}463} = +2{,}011$$

Since the axis in this case passes through the kern, the formula for the stresses in the analogous column takes the form of Eq. 5. Therefore the fiber stresses are:

At A, $+\dfrac{6{,}101{,}800\,(-16)}{2{,}323} = -42{,}000$; at B, $+\dfrac{6{,}101{,}800\,(-16)}{2{,}323} + \dfrac{4{,}469{,}243\,(+20)}{2{,}011} = +2{,}500$; and at D, $\dfrac{+4{,}469{,}243\,(+20)}{2{,}011} = +44{,}500.$

According to the rule, the resultant stresses in the analogous column which give values of moments in the frame are: at A, $-60{,}000 + 42{,}000 = -18{,}000$; at B, $+20{,}000 - 2{,}500 = +17{,}500$; and at D, $+20{,}000 - 44{,}500 = -24{,}500$. The horizontal reaction at G is found from the equation,

$$-24{,}500 - 4{,}000\,(5) + R_2\,(20) = 0$$

Then $R_2 = 2{,}225$ acting leftward, and $M_F = -2{,}225\,(15) = -33{,}375$. The values of applied moment loads and reactions on the analogous column are plotted for this structure in Fig. 3.

Since the stress f at the neutral axis is zero, Eq. 5 again applies.

The slope of the neutral axis is now $\frac{x}{y} = \frac{M_y'}{I_y'} \Big/ \frac{M_x'}{I_x'}$. In this case $\frac{x}{y} = \frac{-4{,}469{,}243}{2{,}011} \Big/ \frac{+6{,}101{,}800}{2{,}323} = \frac{-1.00}{1.185}$.

The neutral axis is plotted on this slope in Fig. 3.

In Fig. 4 the same frame is again shown, but with the ends A and G both hinged. In this case a temporary hinge is also inserted just below the point F, and the frame becomes a three-hinged arch which can carry the load at F as a determinate structure. Some such arrangement as this is necessary in order to secure a moment diagram with which the analogous column may be loaded.

Taking moments at F gives the vertical reaction of the three-hinged arch at $A = \frac{4{,}000\,(15)}{16} = 3{,}750$ acting downward. The horizontal reaction at A, taking ΣH on the structure $ABDF$, is 4,000 acting toward the left. At F the vertical reaction on $ABDF$ is 3,750 acting upward and the 4,000-lb load is applied there. The portion FG is simply a link in this case supporting the rest of the frame.

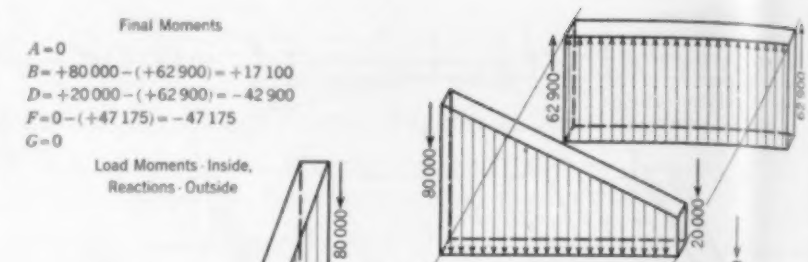

FIG. 4. RIGID FRAME WITH BOTH ENDS HINGED

Figure 4 shows the loading moments on portion $ABDF$ resulting from these loads and reactions. The reaction moments on the entire frame are shown on the same figure.

Since $1/EI$ at the hinges is equal to infinity, a line connecting the hinges is the kern axis of the section, and it is not necessary to consider inclined axes in determining the locations of axes of zero stress. Since the column section and load are on the same side of the kern axis, the fiber stresses will be obtained from the formula, $f = \frac{M_y}{I_y}\,y$.

$$M_y \text{ (about } X\text{-}X) = +800{,}000\,(2/3)\,(20) + 120{,}000\,(20) + 80{,}000\,(20) + 8{,}333\,(18.33) = 14{,}819{,}410$$

$$I_y = \frac{1\,(20)^3}{3} + \frac{1\,(20)^3}{6\,(3)} + \frac{16\,(0.25)^3}{12} + 16\,(0.25)(20)^2 = +4{,}712$$

Fiber stress at B and $D = \frac{14{,}819{,}410\,(20)}{4{,}712} = +62{,}900$.

Resultant moments are, at B, $+80{,}000 - (+62{,}900) = +17{,}100$; and at D, $+20{,}000 - (+62{,}900) = -42{,}900$.

Regarding the member DG as a free body and setting up an equation for rotation at D gives

$-42{,}900 - 4{,}000\,(5) + H_G\,(20) = 0$, or $H_G = 3{,}145$ acting leftward, and the moment at $F = 3{,}145\,(15) = 47{,}175$ (tension in outer fiber).

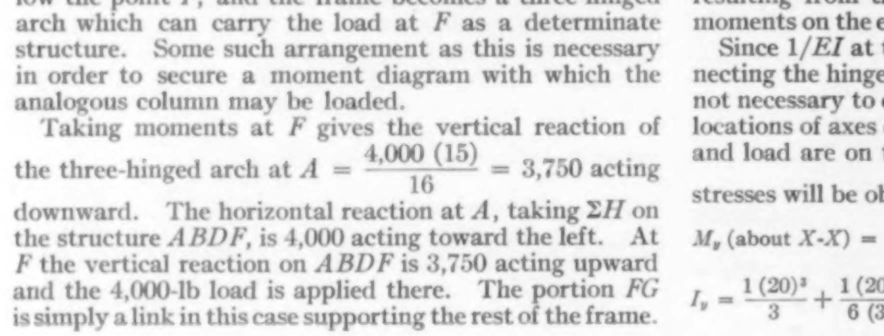

FIG. 3. RIGID FRAME WITH ONE END HINGED

MOMENTS IN CLOSED FRAMES

In Fig. 5 is shown a closed circular section carrying two loads P on opposite ends of a diameter. In order to simplify the problem, $1/EI$ will be considered constant. It is convenient to cut this kind of structure so that one portion reacts against the other. In this case it will be assumed that the frame is severed at A and C and that the upper half and lower half provide reactions

for each other. With these cuts established, moments at various sections of simply supported curved beams may be computed. For the present example, these are tabulated in Table I.

Table I also illustrates the general method of procedure and is more or less self-explanatory. The quarter arc of the circle, in this case, is divided into six equal arcs of length s (Fig. 5, a). Moments are computed at the center of each of these arcs and tabulated. From the data of the table, Ms/EI for each section is computed. When these are added, we have the applied moment load for the quarter of the structure, $0.07137\ PD^2/EI$. The total load $P = \dfrac{4\ (0.07137\ PD^2)}{EI} = \dfrac{0.28548\ PD^2}{EI}$. This load is distributed as indicated in Fig. 5 (b). Since the

TABLE I. CALCULATIONS FOR RING OF FIG. 5

POINT	x	MOMENT	s	Ms/EI
1	0.004 D	0.002 PD	0.13 D	0.00026 PD^2
2	0.040 D	0.020 PD	0.13 D	0.00260 PD^2
3	0.103 D	0.052 PD	0.13 D	0.00676 PD^2
4	0.200 D	0.100 PD	0.13 D	0.01300 PD^2
5	0.312 D	0.156 PD	0.13 D	0.02028 PD^2
6	0.438 D	0.219 PD	0.13 D	0.02847 PD^2
			$\sum \frac{Ms}{EI} =$	$\frac{0.07137\ PD^2}{EI}$

load is symmetrical about the principal axes, the last two terms of Eq. 1 need not be considered, and f equals P/A and is constant over the entire section. Then

$$f = \frac{0.28548\ PD^2}{EI} \Bigg/ \frac{\pi D}{EI} = 0.091\ PD,$$

$$\text{Moment at } A = 0 - (0.091\ PD) = -0.091\ PD$$

$$\text{Moment at } B = +0.25\ PD - (0.091\ PD) = +0.159\ PD$$

Other moments may be obtained by combining the ordinates of Figs. 5 (b) and 5 (c) in the same manner as for sections A and B.

For an unsymmetrical condition, the "moment load" Ms/EI would be obtained from a table similar to Table I, the principal axes located, the "neutral axis" located, and Eq. 1 applied as in former cases.

Reference to Figs. 1 to 5, inclusive, will bring out the fact that in all cases the loads on the analogous column, referred to in this paper as "moment loads," are simply Ms/EI or $M\,ds/EI$ quantities. The unit "moment load" and the unit reaction stress at a given section of the analogous column are therefore intensities of moments M. The resultants of these unit quantities, "moment loads," and reactions are therefore the moments in the rigid frame.

If the elastic curved beam theory had been employed to analyze the frame of Figs. 1 and 2 (both ends fixed), three equations, $\int \frac{M\,ds}{EI} = 0$, $\int \frac{Mx\,ds}{EI} = 0$, and $\int \frac{My\,ds}{EI} = 0$ would have been satisfied. Reference to Fig. 2 will show that these equations are satisfied in the column analogy solution because the summation of the vertical forces Ms/EI on the column is zero, and if moments of these forces are taken about vertical and horizontal axes through A or G, they will equal zero. The same quantities are used in both methods in different ways.

With reference to Fig. 3 (the frame with one end fixed, one hinged) it will be noticed that the summation of the moments of the Ms/EI loads with either x or y coordinates for lever arms will be zero if the hinge at G is taken as the moment center. In other words, $\int_G^A \frac{Mx\,ds}{EI} = 0$ and $\int_G^A \frac{My\,ds}{EI} = 0$. Since $1/EI$ at the hinge G is infinity, G is the only point at which this moment condition

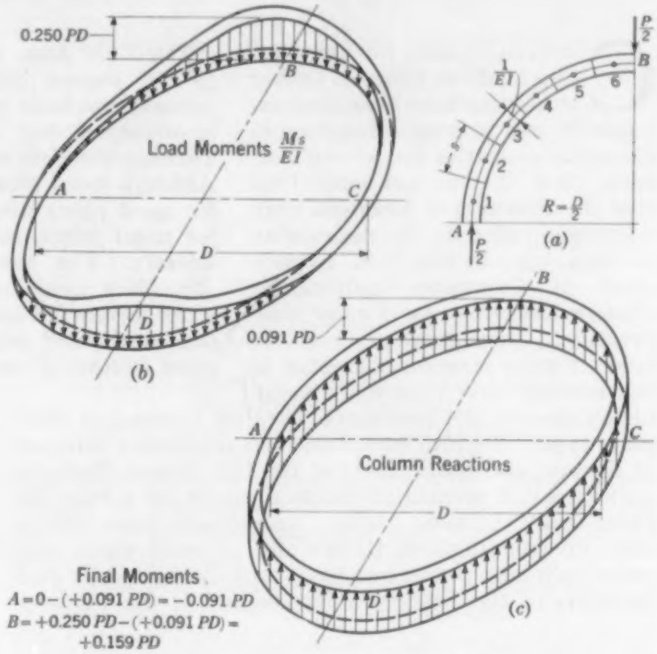

FIG. 5. TREATMENT OF THE CLOSED RING

is true, and the fact that $1/EI$ is infinity at a point in the column causes the relation $\int \frac{M\,ds}{EI} = 0$ to be false. This may be further clarified by noting from Eq. 5 that the G stresses of the analogous column are independent of the direct effect of the applied load $\left(\sum \frac{Ms}{EI}\right)$ on the analogous column since $\sum \frac{Ms}{EI}$ is divided by infinity. Had the elastic curved beam theory been used, the same relations would obtain: $\int_A^G \frac{Mx\,ds}{EI}$ and $\int_A^G \frac{My\,ds}{EI}$ would equal zero but $\int_A^G \frac{M\,ds}{EI}$ would not.

In the case of the frame of Fig. 4 (both ends hinged) the presence of the two hinges gives an axis about which the summation of the moments of the Ms/EI "moment loads" and the summation of the reactions on the analogous column are zero. In this instance the sum of these moments would be $\sum \frac{Mys}{EI}$. For the same reason as in the previous case (Fig. 3) $\sum \frac{Ms}{EI}$ is not equal to zero. The $\sum \frac{Mys}{EI} = 0$ relation alone gives the result desired. If the problem had been solved by use of the elastic curved beam theory, the $\int \frac{My\,ds}{EI} = 0$ relation would have been used, with limits of integration A to G or G to A. For the closed structure of Fig. 5, the similarity of the two methods is apparent.

Tests on Wood Joints with Metal Connectors

Modifications of Flat Split Ring Reduce Deflections

By E. George Stern, Jun. Am. Soc. C.E.

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Joints have been the bottlenecks of framed structure design since framed structures were invented. Any improvement that can be achieved in efficiency therefore merits close attention. Although metal connectors have not done for wood joints what welding has done for metal joints, they represent a great advance. The tests reported here by Mr. Stern would seem to indicate that a still further increase in joint efficiencies can be obtained with close study of selected features of connector details.

Connectors for transferring loads at joints of timber structures have been used extensively and to great advantage in European countries for several decades. But it was not until 1933 that the attention of American engineers was called to the desirability of their use—in the U.S. Department of Commerce publication, *Modern Connectors for Timber Construction.* Since then most of the larger timber structures erected in this country have been made possible by the use of connectors of the ring, toothed, or claw-plate type. Despite numerous tests performed here and in Europe, and particularly at the U.S. Forest Products Laboratory, it seemed advisable to carry out a more detailed study of timber joints. Accordingly, from 1933 to date, investigations on timber and plywood joints with metal split-ring connectors have been conducted by staff members of the School of Engineering of the Pennsylvania State College. The purpose has been to collect data on:

1. Action of the split-ring connectors.
2. Improvement of such connectors by varying the size and shape of the ring.
3. Mechanical properties of heavy structural plywood.
4. Load-carrying capacities and deformation of the rings.

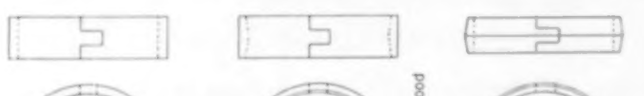

Fig. 1. Split Rings and Modifications

Since three-fourths of the connectors used in the United States are of the split-ring type, the tests were confined to this type, using a ring of $2^1/_2$-in. internal diameter (Fig. 1). Also the tests were limited to Douglas fir—one of the two most important construction species.

In addition to the split ring with straight sides, various modifications were made and tested to determine what sort of outside beveling would most effectively increase the efficiency of the ring. Data were collected on joints with a single ring and compared with data on joints with multiple pairs of rings. Two types of rings (*A* and *E*) were used as indicated in Fig. 1. The results showed that the ring with outside bevels (Type *E*) has numerous advantages over the plain ring (Type *A*) since it gives:

1. A reduced loss of timber cross section in the cutting of the ring grooves because of its comparatively narrow width.
2. A material reduction in joint deformation and therefore greater rigidity at working loads because of its tighter fit in the grooves.
3. Considerably more load at core failure, that is, failure of the wood within the ring.
4. Approximately the same ultimate load.
5. Reduction in the amount of metal in the ring, and hence in the ring weight.

The recently introduced "standard" ring (Fig. 1), with inside bevels, was not used for the tests. Its advantage lies in the ease with which it may be inserted into the grooves, and in the tight fit around the core. Specifications for it are given in the 1939 edition of the *Manual of Timber Connector Construction.*

In Fig. 2 the load transmission for rings of Types *A* and *E* is illustrated. The action of the Type *E* ring

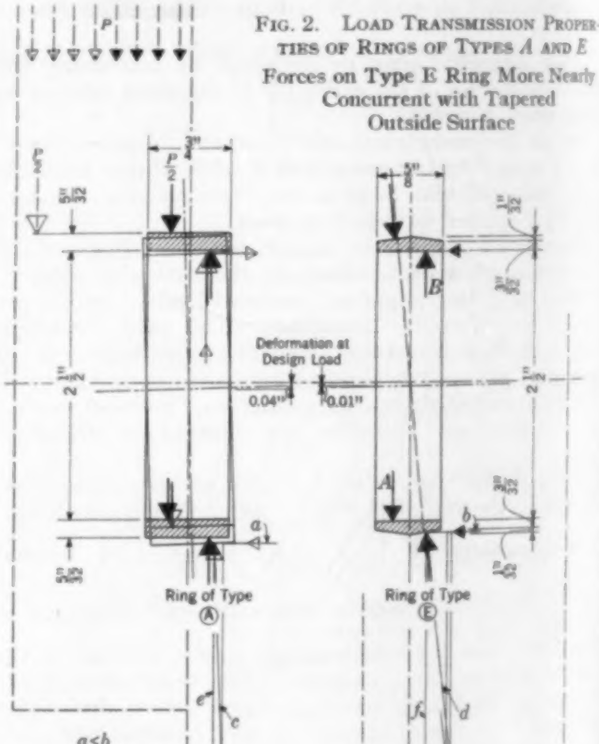

Fig. 2. Load Transmission Properties of Rings of Types *A* and *E*

Forces on Type E Ring More Nearly Concurrent with Tapered Outside Surface

differs from that of Type A in that its first slip proved to be zero (Fig. 3), because of the tight fit of the ring in its grooves. The deformation at working load for a joint with one pair of rings with outside bevels may be computed by dividing the working load by the elastic slope and adding the initial slip at zero load (see Eq. 1 in a later paragraph). By elastic slope is meant the ratio of the load per pair of rings to the elastic deformation (total deformation less initial slip at zero load) within the range below the proportional limit.

In Fig. 4 is indicated the influence of friction, bolt bearing, ring bearing, and cores on the load-carrying capacity and deformation of the joints. Although A-type rings with cores sheared prior to loading carry ap-

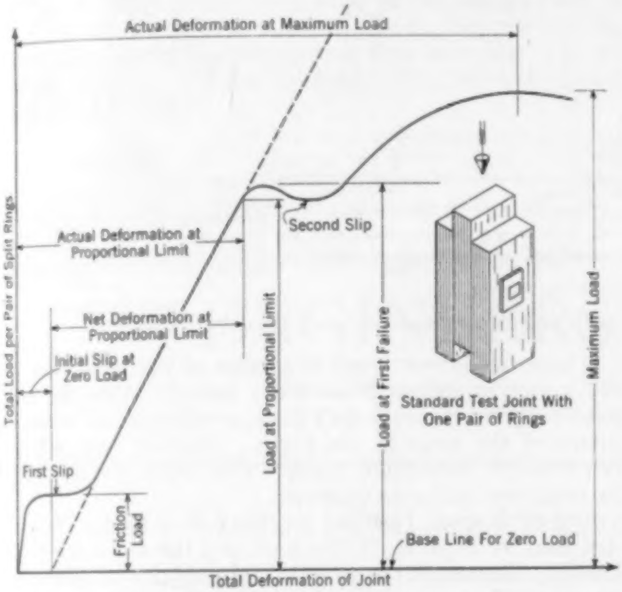

Fig. 3. Terms Used in Characterizing Test Properties

proximately the same ultimate load as those with unsheared cores, they show a much larger deformation at working load. Another factor that affects the load-carrying capacity and deformation of timber joints under stress is the initial bolt tension, probably because of its effect on friction between the members. In the tests the importance of this factor was indicated by the early failure of joints in which the bolt tension was released. Greater initial bolt tension decreases the total deformation and increases the load-carrying capacity of joints with rings of both types.

The application of the standard factor of safety of 3.5 to ultimate loads obtained from tests performed under intermittent-load increase gives values that are from 10 to 20% lower than those obtained from standard tests. Under this loading procedure, during which the influence of time on load and deformation can be observed, timber assemblies with split rings of both types carried approximately the same load at the proportional limit as that obtained under standard loading procedure, while the deformation was increased (Fig. 5). Under repeated loading, the timber assemblies with rings of Type E showed a relatively large elasticity

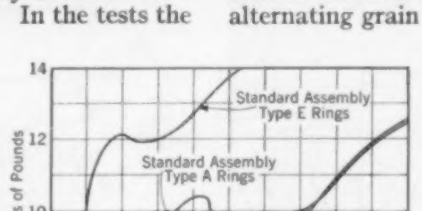

Fig. 4. Typical Load-Deformation Curves—Compression Parallel to the Grain

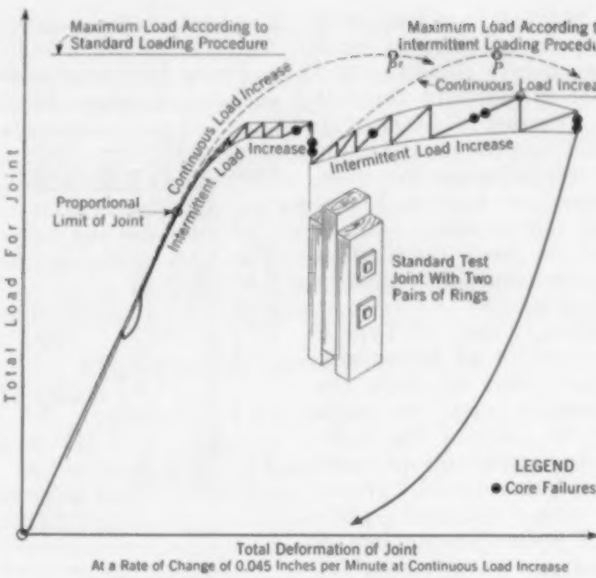

Fig. 5. Effect of Increasing Test Load in Discontinuous Increments

Time Elapsed to P About 90% Greater Than to P'

even after failure of one or several cores. For a limited number of loadings within the proportional limit, the stiffness of the joints increased with an increase in the number of loadings.

In joints with multiple pairs of rings, a distance of $1^7/_8$ in. from the center of the $2^1/_2$-in.-diameter rings to the side margins of the timber, and of 3 in. from the center of the rings to the free unloaded end of the timber, seemed to have the same resistance against failure, and consequently controlled the loads to the same extent, as the spacing of the rings $5^1/_2$ in. on centers in the direction of the applied load and parallel to the grain of the timber. If the end and side margins and the spacing were increased, the load-carrying capacity of the joints would probably be increased.

The strength of structural plywood is less dependent than that of lumber upon the direction of the grain relative to the direction of the applied load because of the alternating grain direction of the plies. However, these relative directions and the thickness of each ply within the ring depth (Fig. 1) do affect the load-carrying capacity of the joints. Test assemblies containing a plywood gusset plate connecting lumber members entering from different directions, indicate that plywood has considerable promise as a gusset-plate material (Fig. 6).

Tests indicated that the safe load-carrying capacity of lumber joints, with one pair of $2^1/_2$-in. rings in dense, coast-type Douglas fir of $2^1/_2$ by 5-in. cross section, was 5,600 lb (factor of safety of 3.5 on the ultimate load). This is in agreement with the results of the tests on the load distribution on various pairs of rings in a joint with multiple pairs of rings spaced $5^1/_2$ in. on centers in series. Therefore, based on a percentage distribution of load, a joint with three pairs of rings in axial arrangement, with rings $5^1/_2$ in. on centers, should carry 13,700 lb (actually the test joint car-

ried 14,650 lb); a joint with four pairs of rings in axial arrangement should carry 14,000 lb (actually the test joint carried 14,800 lb). Considering the many factors that can influence the effectiveness of timber joints, these theoretical findings based on load distribution tests are gratifyingly close to the test results.

Although rings of Type E were used for all joints with multiple pairs of rings, the assumption may be made that the ratio of the load-carrying capacities of such joints with rings of Type A and with "standard" rings would probably be similar. A comparison of test data for joints having multiple pairs of rings, with a vertical spacing of $5^1/_2$ in. on centers and the timber dimensions used in the test, with joints having a single pair of rings, shows that the load-carrying capacity of the rings does not increase in proportion to the number of rings used. Using 5,600 lb as a basis of comparison for the joints with one pair of rings, the ratio of load-carrying capacities of joints with multiple pairs was as follows:

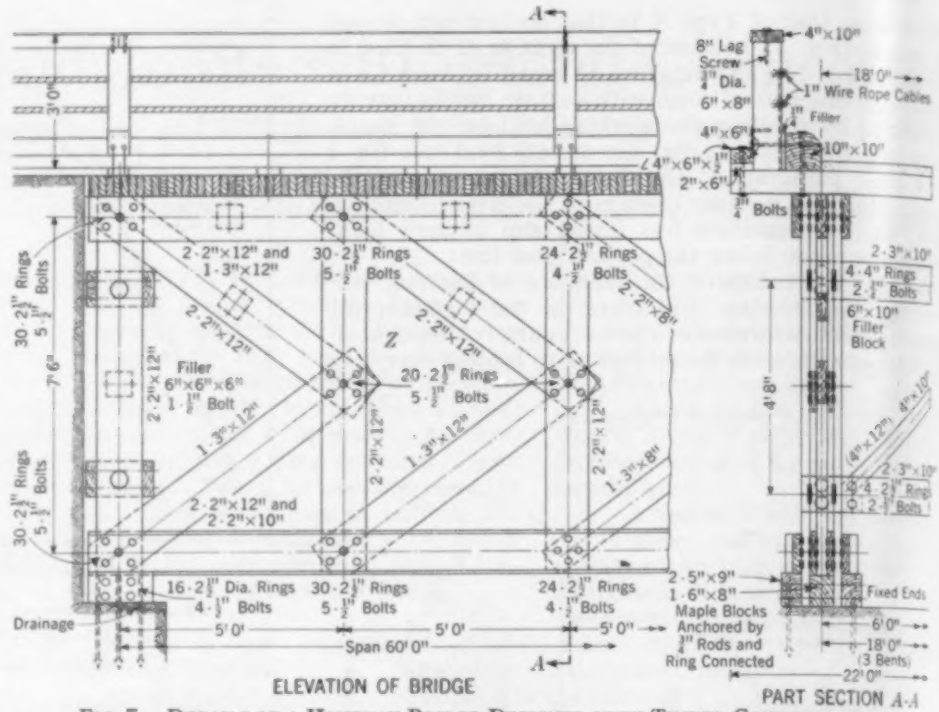

FIG. 7. DETAILS OF A HIGHWAY BRIDGE DESIGNED WITH TIMBER CONNECTORS

	Pairs of Rings					
	One	Two	Three	Four	Five	Six
Minimum	100	140	210	240	360	400%
Maximum	100	180	360	320	520	470%
Mean	100	160	270	270	420	430%

These ratios may vary if species of timber or size of cross section differs from those tested. Also the safe load-carrying capacity may change with various arrangements of the rings in the joints. Further tests will be required to determine these ratios with an accuracy satisfactory for design purposes.

The 60-ft span, two-lane highway deck bridge (Fig. 7) designed by Prof. H. N. Benkert and the writer for H-10 loading, illustrates the practical application of such connectors. Because of the research information available,

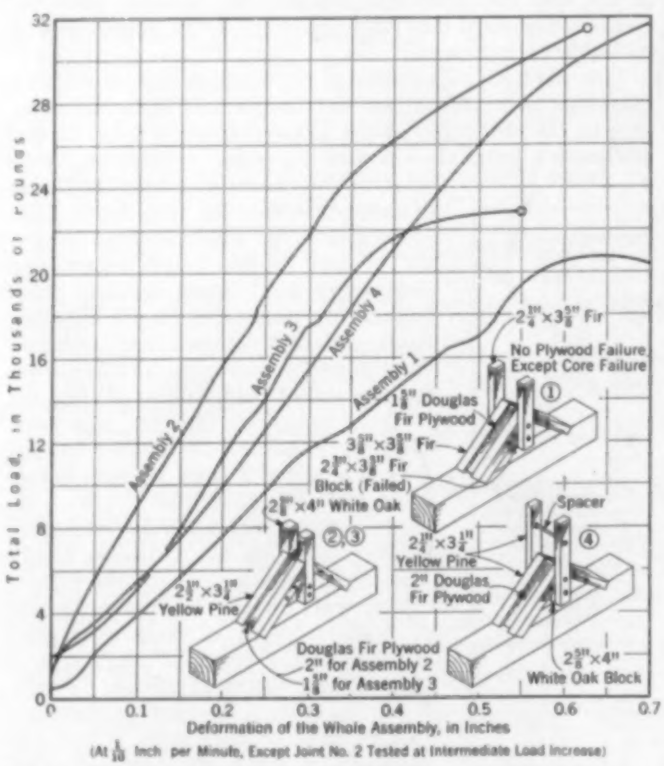

FIG. 6. LOAD-DEFORMATION CURVES FOR PLYWOOD GUSSET PLATES
One Pair of Type A Split Rings Used Where Bolts Are Indicated

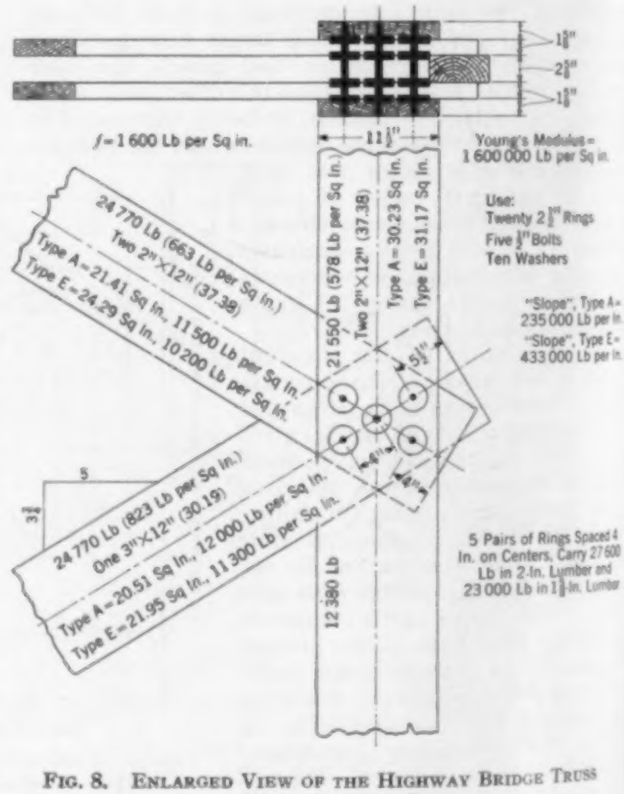

FIG. 8. ENLARGED VIEW OF THE HIGHWAY BRIDGE TRUSS JOINT Z OF FIG. 7

the K-trusses were planned taking into account that the load-carrying capacity of the joints with multiple pairs of rings may not increase in direct ratio with the number of rings. Hence a direct comparison of the design for split rings with straight surfaces, with one for modified rings with outside bevels, might be acceptable.

Calculations and design details for Joint Z in Fig. 7 are shown in Fig. 8. Bolt holes and ring grooves, and the wooden cores within the three pairs of A-type rings, cause approximately 43% loss of cross section in the two 2 by 12-in. diagonals that meet at the center of each vertical. The use of modified rings with outside bevels would result in an 8% reduction of this loss.

The reduction of deformation in a joint in the direction of the two 2 by 12-in. diagonals, at the design load of 24,770 lb, would be 75% of the 0.0226-in. deformation, as determined under the assumption that each pair of rings carries an equal amount of load. This is determined from the equation,

$$\Delta = \frac{P}{n \times E_A} + \delta \qquad (1)$$

where Δ is the deformation, P the stress in the member, n the number of rings, E_A the slope for a joint with one pair of A-type rings (235,000 lb per in.), and δ the initial slipe for a joint with one pair of such rings, or 0.012 in.

The reduction of the weight of the rings used for one of these joints would be (5.68 − 3.62 =) 2 lb, or 36% of the weight of the standard split rings.

According to tests data, merely to replace the $2^1/_2$-in. A-type rings by rings with outside bevels would not affect the load-carrying capacity of the truss, but would cause the following variations:

1. A reduction of the maximum deflection of the truss at its center from approximately 2.04 to 1.68 in., that is, 17.6%.
2. A considerable increase in the rigidity of the bridge.
3. A reduction in the weight of the rings from 1,060 to 680 lb, that is, 380 lb or 36%.

Additional detailed data, bibliography, and glossary on split-ring connectors and structural plywood will be found in the Pennsylvania State College Engineering Experiment Station Bulletin No. 53, on "A Study of Lumber and Plywood Joints with Metal Split-Ring Connectors," by the writer.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Stability of Cantilever Poles in Sandy Soils

By Robert W. Abbett, M. Am. Soc. C.E.
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When a cantilever pole in compacted sandy soil is subjected to a horizontal pull acting near its upper end, the pole tends to rotate about a point on the pole below the surface of the ground. Experiments on such poles indicate that the location of the center of rotation changes somewhat with the magnitude of rotation, but in general it has been found to be a distance of from $^2/_3$ to $^3/_4$ of the imbedment below the surface of the ground, moving upward as the rotation is increased. If the force is increased, the pole finally overturns as a cone-shaped mass of soil is pushed out of the ground, as idealized in Fig. 1.

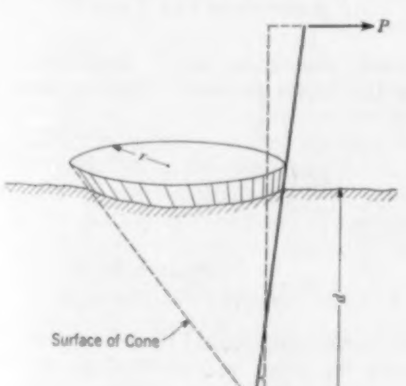

Fig. 1. Soil Cone Displaced by Pole

The resistance to rotation at the instant of impending motion comprises the forces of friction and cohesion acting on the surface of the cone. The resultant of these forces normal to the pole, therefore, must be proportional to the surface area of the cone, which is equal to $\pi r\sqrt{r^2 + d^2}$. (Notation is illustrated in the figure.) If r is expressed as a function of d, the resistance of the soil to lateral motion becomes cd^2, in which c is a proportionality factor or coefficient of lateral resistance which is approximately constant for small movements. Furthermore, in the case of a small lateral movement, y, it may be assumed that the force required to produce the movement is cd^2y.

The application of these relationships in the case of a typical transmission-line pole is indicated in Fig. 2. The parabolic diagram of lateral soil resistance for various depths is shown in Fig. 2 (a), and the rotation diagram for the imbedded pole is shown in Fig. 2 (b). The pressure exerted against the pole for a given rotation as measured by the displacement, e, at the surface of the ground, is shown in Fig. 2 (c). The latter is obtained by plotting the products of corresponding ordinates (horizontal in this case) in the resistance and rotation diagrams. Also, elastic deflection of the pole is neglected.

Equating horizontal forces for lateral equilibrium,

$$\Sigma H = 0 = P - ec\int_0^d \left(x^2 - \frac{x^3}{kd}\right) dx \text{ or } P = ecd^3\left(\frac{1}{3} - \frac{1}{4k}\right) \qquad (1)$$

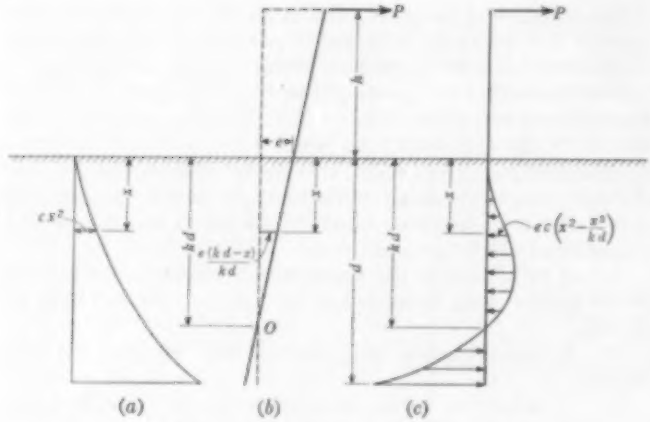

FIG. 2. LOADS AND DISPLACEMENTS
(a) Lateral Resistance of Soil, (b) Displacements, (c) Resulting Pressures on Pole

Also, from $\Sigma M = 0$ with respect to the center of rotation of the pole,

$$P(h + kd) = ec\int_0^{d}\left(x^2 - \frac{x^3}{kd}\right)(kd - x)dx = \frac{ecd^4}{30}\left(\frac{10k^2 - 15k + 6}{k}\right) \quad \ldots\ldots (2)$$

Eliminating the quantity ec from Eqs. 1 and 2 and solving for k gives

$$k = \frac{12d + 15h}{15d + 20h} \quad \ldots\ldots (3)$$

As shown in the graph in Fig. 3, Eq. 3 is discontinuous. A study of this diagram reveals the following characteristics of the behavior of a cantilever pole:

1. For the range of values of h/d normally used for transmission lines, the value k approaches 0.75 as a limit. This value is not greatly different from that determined experimentally.

2. When the load is applied below the surface of the ground (negative values of h/d) the center of rotation moves downward on the pole quite rapidly as h/d decreases.

3. The graph of k becomes asymptotic as h/d approaches -0.75, the value of k approaches infinity, and there is no tendency for the pole to rotate. The motion of the pole in this instance would be that of simple translation.

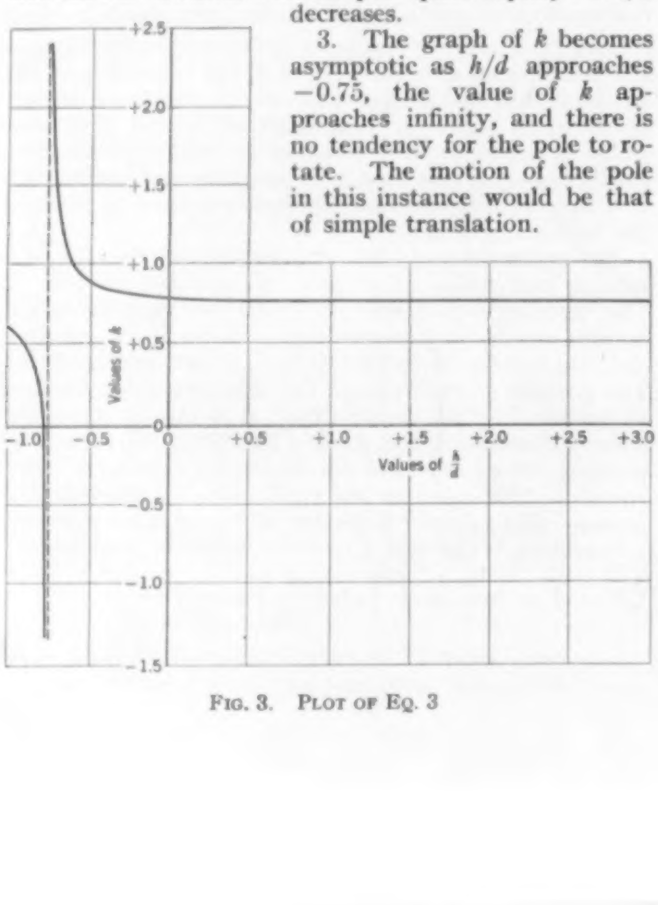

FIG. 3. PLOT OF EQ. 3

4. For a very small range of values for h/d in the vicinity of $h/d = -0.75$, the pole rotates about a center not on the pole but below it when $h/d > -0.75$ and above it when $h/d < -0.75$.

5. For values of h/d varying from -0.75 to -0.80, k has negative values, that is, kd is measured upward from the surface of the ground and the pole rotates about a center above the ground.

6. For $h/d = -0.80$ to $h/d = -1.00$, k again becomes positive and the center of rotation again moves to points on the pole below the surface of the ground.

Referring to Eq. 2, it is evident that the overturning moment about the center of rotation is $M = P(h + kd)$ and the moment resisting rotation is $M = \frac{ecd^4}{30}\left(\frac{10k^2 - 15k + 6}{k}\right)$.

Therefore the required depth of penetration for the pole is

$$d = \sqrt[4]{\frac{30kM}{ec(10k^2 - 15k + 6)}} \quad \ldots\ldots (4)$$

According to this theory, two constants must be known before the stability of the pole can be determined. First, the safe or allowable rotation of the pole, as measured by its movement at the surface of the ground, must be established; and second, it will be necessary to measure the coefficient of resistance, c, by

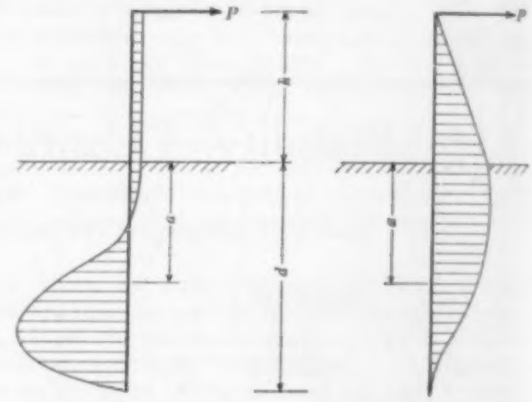

FIG. 4. SHEAR (a) AND MOMENT DISTRIBUTION (b) AS DETERMINED FROM EQS. 7 AND 8

tests on each particular soil. Equation 1 could be adapted to the latter purpose. Solving for c we get

$$c = \frac{P}{ed^2\left(\frac{1}{3} - \frac{1}{4k}\right)} = \frac{12Pk}{ed^2(4k - 3)} \quad \ldots\ldots (5)$$

or, from Eq. 2

$$c = \frac{30Pk(h + kd)}{ed^4(10k^2 - 15k + 6)} \quad \ldots\ldots (6)$$

Thus the coefficient c could be determined by applying known loads to poles set at various depths and by measuring the displacement e. The desired factor of safety in design could be introduced by modifying the working value of either e or c.

The shear at any point on the pole above ground is determined as for any cantilever beam. For any section a distance a below the surface of the ground (Fig. 4), the shear will be

$$V = P - ec\int_0^{a}\left(x^2 - \frac{x^3}{kd}\right)dx = P - ec\left(\frac{a^3}{3} - \frac{a^4}{4kd}\right) \quad \ldots (7)$$

For the ordinary transmission-line pole, the shear will be maximum when $a = 0.75d$ approximately.

In a similar manner the bending moment for any section a distance a below the surface of the ground will be

$$M = P(h + a) - ec\int_0^a \left(x^2 - \frac{x^3}{kd}\right)(a - x)dx =$$
$$P(h + a) - ec\left(\frac{a^4}{12} - \frac{a^5}{20kd}\right) \quad \ldots\ldots (8)$$

Again, for the ordinary transmission-line pole, the bending moment will be maximum when $a = 0.20d$ approximately. However, the maximum moment is only slightly greater than the simple cantilever moment, Ph, at the surface of the ground, and for all practical purposes this may be used.

From Fig. 2 (*c*) the soil pressure at any point is $p = ec\left(x^2 - \frac{x^3}{kd}\right)$. The pressure reaches a maximum when $x = \frac{2}{3}kd$ where $p = \frac{4ec}{27}(kd)^2$. Another maximum exists at the bottom of the pole where $x = d$ and $p = ecd^2(1 - 1/k)$, negative pressures being directed towards the right. These maximum pressures have very little real significance, however, because of the variation in soil resistance.

Simplified Design of Indeterminate Truss Members

By MERHYLE F. SPOTTS

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THE principle of least work provides what is probably the best-known method for determining forces in the members of a redundant truss. Based largely upon the use of the principle by Pippard, the writer has evolved a convenient technique for selecting member sizes in rectangular indeterminate frames. Before presenting this technique, it is desirable to recapitulate briefly the aspects of the least-work principle upon which it is based.

The strain energy of a jointed framework may be found by the equation,

$$V = \sum \frac{F_i^2 l_i}{2A_i E} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where F_i is the force in the bar i, l_i and A_i are its length and cross-sectional area, respectively, and E is the modulus of elasticity. The summation is to extend over all the bars of the truss.

When the framework is redundant, the force in any bar may be considered as composed of two parts: (1) the force that would be present if the redundant members were temporarily removed, plus (2) the effects produced by the forces in the redundant members. The force in bar i then is

$$F_i = F_i' + u_i X_1 + v_i X_2 + \ldots \quad \ldots\ldots (2)$$

where F_i' is the force in bar i if the redundant members were removed; $X_1, X_2, \ldots$, the forces in the redundant members; u_i the force in bar i caused by two oppositely directed 1-lb forces acting in the same place and direction as X_1; v_i the force in bar i caused by two oppositely directed 1-lb forces acting in place of X_2, and so forth. Equation 2 will of course contain as many terms similar to $u_i X_1$ as there are redundants.

Castigliano's theorem is now applied to Eq. 1, and the partial derivatives with respect to $X_1, X_2, \ldots$, are equated to zero.

$$\left.\begin{aligned} \frac{\partial V}{\partial X_1} &= \sum \frac{F_i l_i}{A_i E} \times \frac{\partial F_i}{\partial X_1} = 0 \\ \frac{\partial V}{\partial X_2} &= \sum \frac{F_i l_i}{A_i E} \times \frac{\partial F_i}{\partial X_2} = 0 \\ &\ldots\ldots\ldots\ldots\ldots\ldots \end{aligned}\right\} \quad \ldots\ldots\ldots (3)$$

The modulus E may be canceled from these equations if the frame is assumed to be made up of the same material throughout. The value of F_i from Eq. 2, together with the partial derivatives $\frac{\partial F_i}{\partial X_1}, \frac{\partial F_i}{\partial X_2}$, etc., obtained by differentiating this equation, are now substituted in Eqs. 3, thus giving the equations of least work,

$$\left.\begin{aligned} \sum \frac{(F_i' + u_i X_1 + v_i X_2 + \ldots)u_i l_i}{A_i} &= 0 \\ \sum \frac{(F_i' + u_i X_1 + v_i X_2 + \ldots)v_i l_i}{A_i} &= 0 \end{aligned}\right\} \quad \ldots (4)$$

The usual procedure in designing a redundant truss is to assume the cross-sectional area of each member and substitute these and the known forces and lengths in Eqs. 4. A set of simultaneous equations in the unknowns $X_1, X_2, \ldots$ results, which upon solution will give the value of the redundant forces. Equation 2 is then used to find the forces in the other bars.

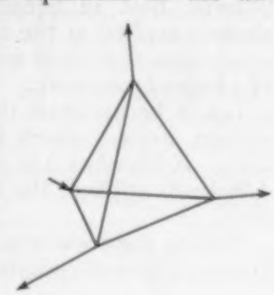

FIG. 1

Not only does the foregoing process involve considerable labor, but it usually results in unit stresses in some of the members higher than the allowable working stress, or conversely it results in stresses that may be too low and wasteful of material. Changes are then made in the assumed areas, and the process repeated until the unit stresses of all members are acceptable.

In connection with Eqs. 4, Pippard (*Analysis of Engineering Structures*, by Pippard and Baker, Longmans, Green and Company, 1936) has made a very important observation. In each of these the term $(F_i' + u_i X_1 + v_i X_2 + \ldots)/A_i$ may be replaced by the resultant unit stress, s_i, giving

$$\left.\begin{aligned} \sum s_i u_i l_i &= 0 \\ \sum s_i v_i l_i &= 0 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Equations 5 are satisfied by merely making a suitable choice for the unit stresses for all the members of the panel. Quite often the stresses for all the members but one are selected, and Eqs. 5 are then used for finding the required unit stress of this last member. Since the cross-sectional areas have not yet been determined, the forces $X_1, X_2, \ldots$ may be arbitrarily designated. As soon as

these are fixed, the total force in each member will be known, and the area can then be found immediately by dividing by the previously chosen respective unit stresses. In general, considerable savings of labor can be effected by this process, which is called by its originator the method of direct design.

For economy of material it is desirable to have the same unit stress, s_t, in all the tension members, and the same unit stress, s_c, in all the compression members. As an extension of Pippard's idea, let it now be required

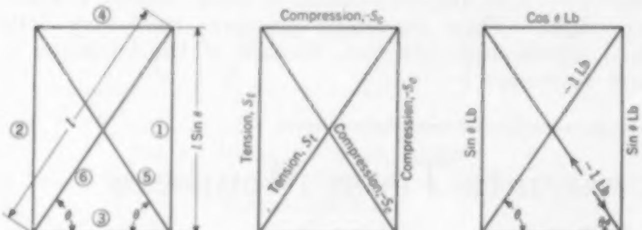

FIG. 2

to determine the conditions which a redundant structure must fulfill to make this statement concerning unit stresses true for all the members.

Consider the once redundant elementary panel of six bars shown in Fig. 1, which is kept in equilibrium by a suitable set of external forces applied at the vertexes. Inspection plainly indicates that only by a most unusual combination of forces and dimensions could Eq. 5 and the restriction regarding the uniformity of the stresses be simultaneously fulfilled. Such being the case, the remarks that follow will apply only to rectangular frames.

Consider now the panel shown in Fig. 2(a), which is likewise held in equilibrium by external forces (not shown) applied at the corners. This frame may be the whole structure, or it may be one of the panels taken out of a larger framework.

Let it be assumed that the given loading causes resultant stresses which have the signs indicated in Fig. 2(b). If Member 5 is chosen as the redundant, and the 1-lb loads applied, the u forces will be as shown in Fig. 2(c).

Taking the members in order 1, 2, 3, ..., and calling tension plus and compression minus, Eq. 5 becomes

$$-s_c l \sin^2\theta + s_t l \sin^2\theta + s_t l \cos^2\theta - s_c l \cos^2\theta - s_c(-1)l + s_t(-1)l = 0$$

$$s_t(\sin^2\theta + \cos^2\theta - 1) - s_c(\sin^2\theta + \cos^2\theta - 1) = 0$$

The terms in both parentheses are equal to zero, and Eq. 5 is accordingly fulfilled. Therefore it may be said that if all tension members are to have the same stress s_t, and all compression members the same stress s_c, then it becomes necessary for only one vertical, one horizontal, and one diagonal member of the panel to be stressed in tension, and for the remaining three members to be in compression.

The foreging requirement may usually be achieved by keeping the direction and magnitude of the redundant forces X_1, X_2, ... within certain definite limits. For illustrative purposes the truss shown in Fig. 3(a) may be considered. If members CH and DG are taken as the redundants, the primary force system will be given by Fig. 3(b). In panel $BCGH$ the force X_1 must be directed as shown in Fig. 3(c), and have a value somewhere between zero and 2,500 lb. Otherwise the resultant stress of both diagonals would be of the same sign, and the foregoing requirement with respect to the signs of the stresses would not be adhered to.

Taking CH at, say, 1,500 lb, the resultant forces will be as in Fig. 3(d). The u forces are shown in (e), and taking the members in the same order as before, Eq. 5 is satisfied:

$$-s_c(-{}^3/_5) \times 3 + s_t(-{}^3/_5) \times 3 + s_t(-{}^4/_5) \times 4 - s_c(-{}^4/_5) \times 4 + s_t \times 1 \times 5 - s_c \times 1 \times 5 = 0$$

Turning now to panel $CDFG$, a compressive force will be required in DG so that X_2 will appear as in Fig. 3(f). In magnitude it must lie between zero and 7,500 lb.

Taking DG as 3,000 lb, the forces will be as in Fig. 3(g). The v forces are given in (h). Equation 5 becomes,

$$s_t \times {}^3/_5 \times 3 - s_c \times {}^3/_5 \times 3 + s_t \times {}^4/_5 \times 4 - s_c \times {}^4/_5 \times 4 - s_c(-1) \times 5 + s_t(-1) \times 5 = 0$$

The resultant forces in the truss members are shown in Fig. 3(i). The areas of the tension members are found

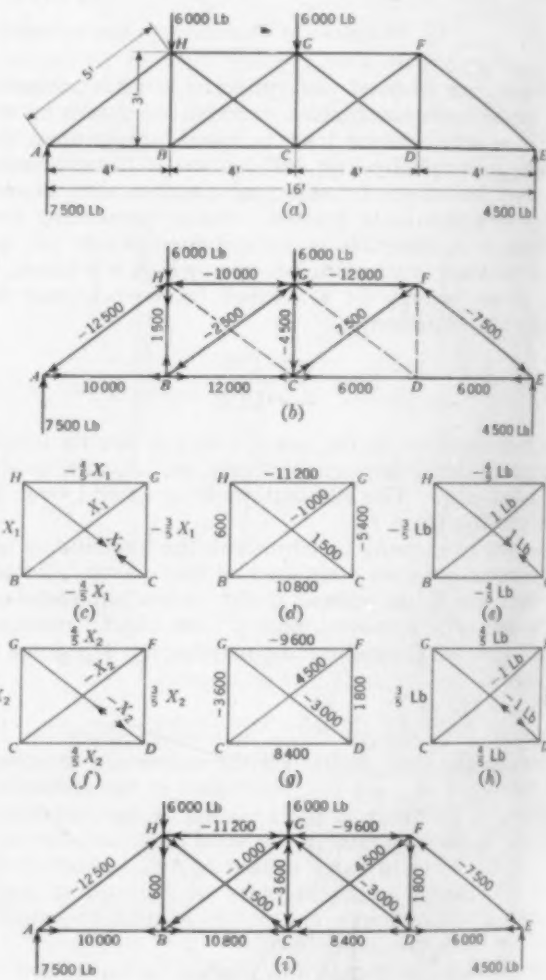

FIG. 3. EXAMPLE OF DIRECT DESIGN BY METHOD OF RESTRICTED FORCES

by dividing the tensile forces by the chosen s_t; and the area of the compression members, by dividing by s_c.

The foregoing procedure is predicated on the assumption that it is possible to make each member exactly the required size. Often this cannot be done because of the necessity of utilizing commercial shapes. There will then be certain variations in the unit stresses of the different members. The sizes of the chords should first be determined for best economy. Equations 5 may then

be brought into balance by making small adjustments in the areas of the web members. If some of these latter cannot be made to carry the full working stress, the loss will usually be slight since their forces are relatively small as a rule.

While the tension members should be large enough to carry the load in the net section, the gross areas should be used for finding the stresses of Eq. 5. Finally, the compression members may be checked for buckling with a table of struts.

A Portable Electric Water-Depth Gage

By H. G. Wilm *and* M. H. Collet

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To meet the growing need for a portable instrument capable of accurately indicating water depths in wells and channels over a considerable range, the point gage illustrated in Figs. 1 and 2 was designed. As in other electric point gages, the distance of the water surface from a reference point is measured with a plumb-bob suspended on a graduated steel tape. Contact of the bob with the water surface closes an electric circuit which activates the needle of a milliammeter.

As shown in Fig. 2, the instrument is compact and very simple in construction, with no complicated wiring or small parts. The reference point is provided by a plug-in socket which is fastened with screws to any level support above the water. From a binding-post in the bottom of the socket, a ground wire is carried into the water. Duplicate sockets make the gage usable at any number of gaging points, each with a reference socket of known elevation. When the instrument is plugged into the socket its base rests on a ring-shaped shoulder, while the ground (negative) portion of the circuit is carried through the base to the lowest battery by means of a male plug element.

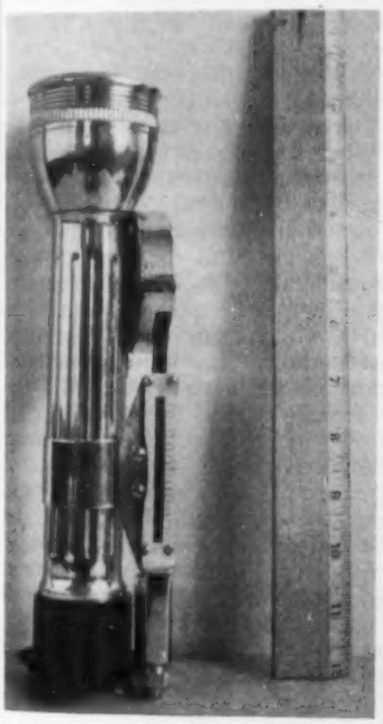

Photo by U.S. Forest Service

Fig. 1. Point Gage Assembled and Mounted in Socket

Passing through a series of three standard $1^1/_2$-v flashlight batteries, the circuit enters the top element of the gage, consisting of a spring contact, a 5,000-ohm fixed-resistance unit, and a milliammeter registering up to 1 ma. This combination of voltage, sensitivity, and resistance makes it possible to obtain readings in practically pure water; at the same time there is no danger of burning out the milliammeter by a direct short-circuit. The second pole of the milliammeter is grounded by a spring contact to the metal case and measuring tape, which carries the circuit back to the water surface.

The measuring tape is of $^1/_4$-in. steel ribbon, 25 ft long, graduated in feet, tenths, and hundredths. A special housing and three set-screws hold the standard tape in place and permit easy removal of both tape and case for repair or replacement. A metal guide bracketed to the side of the battery case insures free movement of the tape at all times and provides a suitable measuring plane for reading the tape. When not in use, the tape is rolled in its case and the plumb-bob is held solidly in a cylindrical metal sheath affixed to the lower end of the metal guide.

Without switches and without any wiring except that directly connected to the milliammeter, the instrument can be completely disassembled by unscrewing the female socket and the top ring. A disk shield protects the milliammeter face from damage. The assembled point gage is very little heavier or bulkier than an ordinary three-cell flashlight and is sufficiently sturdy to give service for an unlimited period of time under normal field usage. All the instrument parts that are subject to wear or breakage are standard manufactured equipment.

This gage, for which a public patent has been applied for, was developed by the U.S. Forest Service and has been used successfully on several experimental watersheds in the West. In the field the gage has proved a particularly efficient means of determining instantaneous water stages in flumes, weirs, ground-water wells, and runoff collector tanks. It was possible under field conditions to obtain vernier readings with the instrument to the nearest 0.001 ft, and with care to duplicate such readings within 0.001 ft above or below the average of several measurements. This degree of consistency, together with the instrument's portability, has made it an effective low-cost device for setting and checking a series of automatic, water-stage recorders. In general, it should be helpful wherever there is an engineering problem calling for accurate and efficient determination of the level of fluids (electric conductors) in wells, channels, tanks, or reservoirs.

Photo by U.S. Forest Service

Fig. 2. Point Gage Dismounted and Unassembled

Left to Right Are Threaded Top Ring and Shield; Milliameter; Battery Case, Tape, Vernier, Plumb-Bob Sheath and Bob; Batteries; and Socket Showing Male Plug

Simplified Flood Routing

By OTTO H. MEYER, ASSOC. M. AM. SOC. C.E.

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IN investigations of rivers for flood control, or in similar hydraulic studies, flood routing is likely to play an important part. This is at best a complicated and laborious procedure; consequently a simplified method, reducing to a minimum the time and labor required, should be of value. Such a method has recently been developed and is now in use in several offices of the U.S. Engineer Department.

Existing methods for routing floods in rivers depend on flow-storage curves. These curves express the functional relation between the discharge, or outflow from a reach, and the storage, or volume of water within the reach. They may be derived by constructing stage-storage curves from contour maps or cross sections and combining these with stage-discharge relations; or they may be constructed from historical floods with known inflows and outflows by reversing the routing operation, as will be described here. In any case, this functional relation remains the same whatever method of routing is used. The relation is generally considered as instantaneous, not involving time. In reservoirs or deep rivers, where pressure wave transmission has a major influence on behavior, this is practically true. In long reaches or shallow rivers, on the other hand, time becomes an important factor. Sudden changes in the rate of inflow, though they affect the storage immediately, do not affect the outflow until the rise or drop has had time to work down through the reach. Some methods of correcting routing for this effect, such as those considering "wedge storage," merely add complexity to the problem. The introduction of this "time of travel" actually can reduce the routing procedure to the ultimate in simplicity, through application of what is here designated the lag method.

The essence of the lag method of routing is that the storage at a particular time governs the outflow at some subsequent time. The time lag from the existence of a certain storage to the occurrence of the corresponding outflow results from the travel of the flood downstream. The stage at the mid-point of a reach is related to the storage in the reach, and is also related to the flow at that point. The flow at the mid-point of a reach is approximately the mean of the flows at the upper and lower ends of the reach. However, the flow at the lower end changes as time passes, until, after the lapse of the period required for travel through the reach, the flow at the lower end becomes approximately equal to the previous flow at the upper end. As the mean outflow of this period is approximately the mean of these two flows, it is also equal to the flow at the mid-point at the beginning of the period. This is also the outflow at the middle of the period. Thus the lag from storage to outflow is one-half the time of travel through the reach. It follows that an instantaneous storage determines not only a subsequent instantaneous outflow, but also the mean outflow of a period whose mid-point is subsequent to this storage by the amount of the lag.

The fundamental storage equation, on which most routing methods are based, is

$$I - O = S_2 - S_1 \ldots\ldots\ldots\ldots\ldots (1)$$

where I is the volume of inflow during a period (for a unit time numerically equal to the mean rate of inflow), O the outflow, S_1 the storage at the beginning of the period, and S_2 the storage at the end of the period. The inflow is known; the storage at the beginning of the routing is either known or estimated; and outflows and subsequent storages are to be computed. Thus in Eq. 1, I and S_1 are known quantities, and O and S_2 are unknown. However, if the lag is one-half of the time unit used, O is a function of S_1, and is determined by means of the storage curve; S_2 is then found by simple arithmetic. The process is carried on continuously through the succeeding time units.

Routing by this method may be done with a minimum of labor by the use of an adding machine. The first inflow is added to a starting value of storage. The outflow is found from the initial storage by means of the storage curve, and is subtracted. A subtotal is registered, giving the next storage. The next inflow is then added, outflow from the second storage subtracted, and so forth. The routing is thus performed at high speed. No computation form is needed, as inflows are read from tabulated data and outflows are identified for subsequent tabulation by their negative signs on the tape.

In general, the most convenient period or unit for routing is one day. Thus when the lag is 12 hours the storage at midnight determines the mean outflow of the following day. When the lag is greater than 24 hours the mean outflow of the second day following corresponds more nearly to this storage. In that case the outflow may be determined not only for the day currently being computed but also for the following day. If the lag is considerably less than 12 hours, a period shorter than one day, and equal to about twice the lag, must be used as the routing unit; thus for a one-hour lag a period of two hours may be used as the unit.

Lag can best be determined in connection with the construction of the storage curve from a historical flood. Known outflows are subtracted from known inflows, and the differences, which are increments of storage, are accumulated algebraically. The time interval found between the maximum storage and the maximum outflow should be the lag. Storages are plotted against corresponding outflows, consideration being given to the lag, and the plotted points are joined by lines in chronological order. There will result a loop or series of loops. The use of the correct lag will result in the narrowest loops, and with this kept in mind the value of the lag may be determined closely

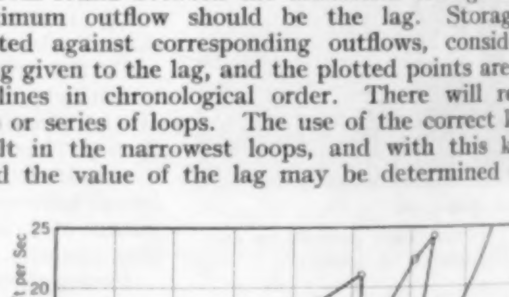

FIG. 1. DEVELOPMENT OF TYPICAL STORAGE CURVE FROM FLOOD RECORDS

by a series of trials. The representative, or average, slope of these loops at each level of outflow is determined. These slopes are then integrated into a continuous storage curve. Such a series of loops and the resulting storage curve are illustrated in Fig. 1.

When the storage is determined from maps or cross sections, the lag may be found by estimating the time of travel through the reach. The lag is one-half of the time of travel, as mentioned previously.

An indication of the time of travel may be obtained by examination of the storage curve. Storage divided by discharge has the dimension of time, and represents the mean time that water is in the reach. The "time of travel" discussed here is the time of travel of the flood, or of changes in flow, rather than the mean time of travel of the water. In a reservoir the actual velocity of the water is very low, and the time of passage through the reservoir is great, yet changes in the rate of inflow are reflected almost instantaneously in the outflow. In a river with a very uniform, constricted channel, the velocity of the water itself may be practically as great as that of stage transmission. Thus, when the mean time during which water remains in a reach is determined from a storage curve by dividing a storage by the corresponding outflow, the "time of travel" for this reach may be anywhere between this value and zero, depending on whether the characteristics are more nearly those of a channel or of a reservoir. The proportion of the computed time to be used will thus have to be determined by an investigation of the reach, to see whether areas of slack water will be found, or whether constricted control points will back up the water in pools. Experience may eventually make possible the establishment of criteria for this determination.

It will be noted that the time of travel will vary with the stage. For convenience in computation an average value is used. In order to avoid inconsistencies in the routing it has been found advisable to use a time not greater than the inverse slope of the steepest portion of the storage curve.

A sample routing computation is shown in Table I. Inflows are assumed to be as shown, and the beginning storage and first day's outflow are assumed to be zero. The sample storage curve of Fig. 1 is used, with a time of travel of one day.

In addition to saving time and labor, this routing method has the advantage over some others that the inflows used may be mean daily flows, which is the form in which most of the available data exist. Outflows are then also mean daily discharges. The shape of a hydrograph will be reproduced with a high degree of fidelity, for there is no extrapolation such as causes a "hunting" effect in methods using instantaneous flows; sudden change or complete cessation of inflow is responded to, where other methods give impossibly high peaks or negative values. If better definition of the shape of the hydrograph is desired, a unit of time about two-thirds or two-fifths of the lag may be used, in which case a storage value determines the mean outflow of the second or third unit following. In one case of very slow overland flow, a lag of $5^1/_2$ days was used successfully with a one-day time unit, the storage in this case determining the outflow of the sixth day following.

Table I. Sample Routing Calculation

Day	Inflow Cu Ft per Sec	Outflow Cu Ft per Sec	Increment Sec Ft-Day*	Storage Sec Ft-Day*
1	3,000	0	3,000	
				3,000
2	8,800	200	8,600	
				11,600
3	15,750	1,700	14,050	
				25,650
4	11,200	8,500	2,700	
				28,350
5	6,250	10,900	−4,650	
				23,700
6	3,300	7,100	−3,800	
				19,900
7	1,700	5,000	−3,300	
				16,600
8	900	3,500	−2,600	
				14,000
9	500	2,400	−1,900	
				12,100
10	300	1,800	−1,500	

* The sec ft-day is the amount of water contributed by 1 cu ft per sec flowing for 1 day, or approximately 2 acre-ft.

It should be noted that the applicability of this method is restricted to cases where the lag is not much less than half of the smallest practicable time unit into which the inflow hydrograph may be divided for routing. If the use of a sufficiently small unit is not found to be practicable, or for the case of a reservoir, the routing must be performed by some other method. Where the lag method can be used, however, it will be found simple, rapid, and accurate.

The methods of constructing storage curves mentioned here are based on those given in the paper on "Flood Routing," by Edward J. Rutter, Quinton B. Graves, and Franklin F. Snyder (Transactions, Am. Soc. C.E., Vol. 104, 1939, page 275).

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Protection of Hangars

To the Editor: It is gratifying to find that engineering attention is turning to a consideration of the many problems inherent in the defense of air bases, as evidenced by Mr. Hersum's article in Civil Engineering for December.

But first let us see what, from a military standpoint, the protection we seek is for—and against. Quoting from the article, it may be that, "Basically the idea of facilities for placing the light pursuit planes in the air from protected hangars is sound." Again quoting, it may be that "The best defense . . . is the provision of pursuit ships located at the base or subbase, provided they can get aloft rapidly," and that "An adequate warning system coordinated with protecting planes is the best defense." However, considering the cost of providing positive static protection against bombardment by heavy aerial bombs, and the fact that the last place a pursuit airplane should be during a bombing raid is on the ground, protection of these airplanes in such a manner seems inconsistent.

The range of friendly bombing aircraft permits assembly of tactical operating units from such widely dispersed fields that bombing attacks against any single base may be made unprofitable from a military standpoint. But why dwell on a single phase of a large problem?

The three words—dispersion, camouflage, and concealment—convey suggestions as to effective though unspectacular means of protecting airplanes from bombing attacks and the necessary installations for their maintenance and operation on the ground. Essential protection against sabotage, parachute troops, and air infantry has been largely ignored in airport layouts to date. Naturally modifications in the interest of such protection will cost money. It is along these lines that the engineering profession, knowing the enormous effort and cost of bomb-proofing on the one hand and the defenselessness in war of most airports on the other, can further national defense by ensuring that the relatively minor added costs accomplish the proper objective. Offensive war efforts generally focus against lines of communication, and no one should longer entertain doubts that air bases form worthwhile objectives for attack by one means or another. As Mr. Lewinwell said in the same issue, there is little difference between military and civilian air fields in time of war.

CHARLES Y. BANFILL
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Economic Design of Waterways and Gates

TO THE EDITOR: The paper by Messrs. Rich and Riegel, in the February issue, is a review of much of the progress that has been realized in hydro plant design in recent years, and it is of such timely interest that it is to be regretted it could not have been published in full as it was presented at the Cincinnati Meeting of the Society.

I would like to comment on one or two parts of the article in which I am particularly interested. In the discussion of gates for low-head dams, it is intimated that roller drum gates are in order where large amounts of ice or floating debris have to be dealt with, as on the upper Mississippi River. From comparison of a considerable number of published and unpublished data, it appears reasonable to assume that for identical conditions and exclusive of guides and hoisting machinery, roller drum gates would weigh from 1.8 to 2.3 times as much as vertical lift gates and from 2.5 to 3 times as much as radial gates. On the basis of such estimates it would seem that only very compelling reasons could justify the adoption of roller drum gates for a dam with a long overflow crest. Two dams on the lower Susquehanna River, which has a record flood of more than twice that of the Mississippi above the Missouri and where occasionally an enormous amount of ice as well as trash has to be passed, are equipped with vertical lift gates. Experience on these dams, as well as on Canadian dams equipped with gates of the same general type, has shown that vertical lift gates of about 50-ft clear opening can cope with the most severe ice or trash runs, and makes it appear doubtful whether the substantially higher investment required for roller drum gates is necessary even under the worst conditions.

On the other hand, it may be asked whether the radial gate, which requires the least amount of material of any of these three types, has not been unduly neglected in recent times. In addition to its inherent low weight, the radial gate requires less space to be taken up by piers, has very simple mechanical features, and can be operated with relatively light hoisting apparatus. The one strong and, in some cases, decisive reason for preferring vertical lift gates to radial gates in spite of these advantages is the ease with which the former (provided the dam is equipped with gantry cranes) can be transported, exchanged, and replaced, and with which spare gates can be put in emergency gate slots. Where emergency closure, interchangeability, or easy access for maintenance painting is less important, however, it appears that economy would tend to favor the radial gate.

I fully agree that roller trains for vertical lift gates are properly considered a thing of the past. Tests on the Safe Harbor Dam, where flood gates with roller trains and emergency gates with fixed rollers (which have plain bearings) of comparable weight are operated under identical conditions, have shown that the difference in friction under average operating conditions between the two types is much less than had commonly been assumed. There may be some question with regard to the justification of ball or roller bearings because the capacity of lifting equipment is usually set with a margin of safety against which the possible difference in friction between the two types of bearings is negligible. In northern climates at least, where dependable operation at very low temperatures is essential, it would perhaps be better economics to apply the expense required for anti-friction bearings to increased facilities for heating seals and roller tracks.

In large low-head dams, whether they be multi-purpose or built only for power generation, the investment in spillway gates and accessories is usually one of the largest single items of cost. Literature on this subject is relatively scarce and, therefore, a paper written as competently as this one is of lasting value to the profession.

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Baltimore, Md.

Testing for Cavitation

TO THE EDITOR: In connection with Mr. Davis' article on "Cavitation Laboratory Practice," in the March issue, it seems to me that it would be desirable to standardize the notation in the Thoma formula. Mr. Davis uses H_B to mean atmospheric pressure and calls it "barometric" pressure. This term is often used meaning atmospheric pressure as given by a mercury barometer. The writer has used H_a for this term, and has put $H_a - H_v = H_b$, calling H_b the height of a water barometer. Then the Thoma formula becomes simply $\sigma = \dfrac{H_b - H_s}{H}$.

The testing of an actual turbine model in water is preferred to air for cavitation testing. The air tests permit calculating where cavitation would occur if the fluid were water, but do not develop actual cavitation—the formation of a condensable vapor pocket in a liquid—although the air tests may develop separation. Air tests give no information beyond the cavitation limit, and do not show what happens when cavitation occurs or just begins. The occurrence of an actual critical point, due to abrupt change from liquid to liquid plus vapor, is believed a valuable feature of water tests that cannot be utilized with tests in air.

L. G. MOODY
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Philadelphia, Pa.

TO THE EDITOR: In Mr. Davis' article, in the March number, is presented an interesting history and discussion of the methods employed both here and in Europe in the testing of model turbines for cavitation.

In endeavoring to improve the performance of a model runner with respect to cavitation, it is frequently found that very small changes in the shape of a propeller runner blade will produce a considerable change in the cavitation characteristics of the runner, both in respect to the critical sigma at which cavitation commences, and also in determining at what point on the blade the cavitation is first evident as indicated by the stroboscope. In some cases the change in shape may have almost no effect on the performance at sigma values above the critical. In such cases it would appear that the change has not altered the total pressure difference between the face and back of the blade, but has changed the pressure distribution on the blade.

PHOTOGRAPH SHOWING TEMPLATES USED IN CHECKING THE BLADE SHAPES

A recent series of tests has furnished additional evidence of an independent nature that changes in blade shape producing almost no effect on the horsepower and efficiency characteristics of the runner

may very materially alter the distribution of pressure. In these tests the combined hydraulic and centrifugal moment tended to turn the blade shank, as shown by the curves in the accompanying Fig. 1. The hydraulic moment exerted on the blade was very considerably changed, indicating a pronounced change in the pressure distribution. At the same time the performance of the runner with respect to output and efficiency was almost the same.

In the accompanying photograph the templates used in checking the blade shapes are shown. These templates are first used with the rough blade casting to detect any distortion occurring in the casting and also to establish the proper centers for the machining of the blade shank. If any distortion is present the blades can be corrected before the layout is made, and the templates made to serve as a guide in the hand finishing of the blade surfaces.

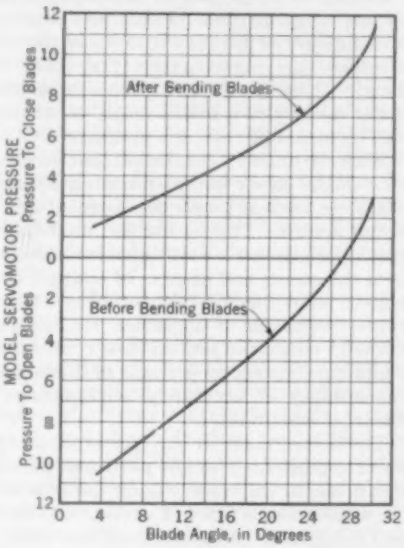

Fig. 1

Before the shape of a finished blade is altered, a plaster cast is made of both the face and back of the blade so that it can later be returned to its original condition if desired. New templates providing for the desired alteration are then prepared. It is essential that they extend over the entire blade rather than only over the section to be altered, since the varying thickness of the blade sometimes makes it difficult to bend the blade at the desired point without distortion elsewhere, and a check on the shape of the entire blade is necessary.

By the use of these templates and cast, it is possible to try a number of alterations on a single set of blades, noting the change in characteristics caused by each alteration. If more extensive tests are desired, it is also possible to restore the blade accurately to any previous shape.

In describing the testing of hydraulic turbines with air instead of water, Mr. Davis states that "there is no essential difference between the use of water and the use of air." It would seem, however, that the two procedures are actually quite different. In testing with water, the usual method is to lower the sigma until cavitation commences, as evidenced by a change in the performance of the unit or by direct observation with stroboscopic light. In testing with air no cavitation can occur, and to predict the critical sigma it is necessary to make observations of the actual pressures at a number of points on the blade itself. Once the pressures at all points of the blade are known in relation to the pressures in other parts of the unit under test, it is possible to predict at what sigma cavitation will occur when operating with water.

R. E. B. Sharp
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Philadelphia, Pa.

California May Have Longest Covered Span

To the Editor: An article in the January issue of Civil Engineering ("Anatomy of an Old Covered Bridge" by Irving A. Jelly) implied that the 190-ft spans of the Columbia Delaware Bridge were the longest covered spans in the country. Challenges may be expected from many sources, as the *Engineerogram* (organ of the Sacramento Section) surmises.

We submit for California's entry the Bridgeport Bridge over the South Fork of the Yuba River, a county bridge being used to detour traffic from Nevada City to Downieville via French Corral. At our request, Assistant Highway Engineer A. C. Irish made the following measurements: Clear span, 213 ft; deck length, 233 ft; shed length, 251 ft; roadway width, 15 ft; and deck above bed, 34 ft. Built by J. W. Woods in 1862, this bridge is said to have carried 13 tons recently, but is now limited to four tons. See Morley's *The Covered Bridges of California*, pages 50 and 51, for photographs and description.

R. Robinson Rowe, M. Am. Soc. C.E.
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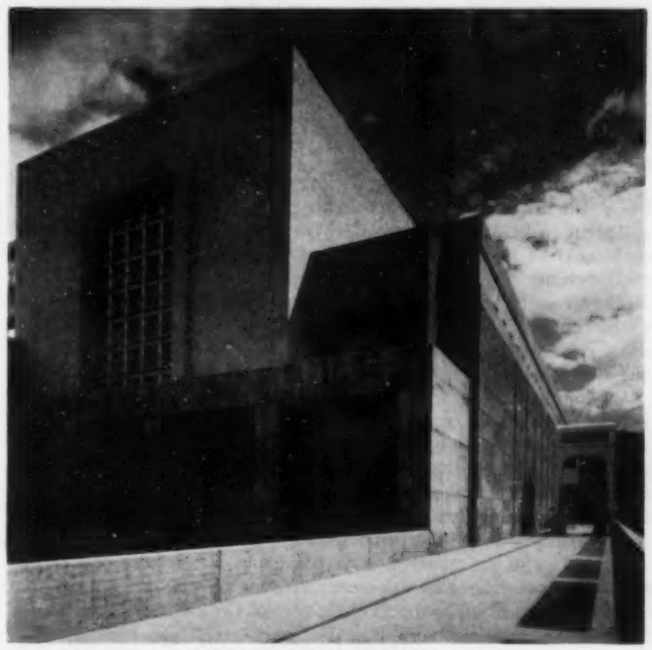
Sacramento, Calif.

Engineers and Architects Cooperate on TVA Projects

To the Editor: In connection with Mr. Lewis' paper on the "Esthetic Responsibilities of the Engineer," in the March issue, I should like to review briefly the accomplishments of the Tennessee Valley Authority in securing the collaboration of its engineers and architects in developing unity between the functional engineering requirements and the purely esthetic elements.

Since its inception by Congress in 1933, the TVA has attempted the systematic development of an entire river system in terms of unity and interdependence of all natural resources in the area. No one thing has been done that has not first been examined in terms of its effect upon other activities and objectives. Decisions were not entirely engineering, economic, or political in nature. The biological, social, and esthetic aspects were also considered, so that



View Showing the Massive Beauty of Guntersville Power House

Overlook Building at Guntersville Dam

ELEVATOR PENTHOUSE AT NORRIS DAM

each part of the work would acquire a certain dignity and strength from its association with the whole.

In addition, the new element of public relations had to be considered. From the very beginning the TVA was confronted with a situation for which there was practically no precedent. There was no record of the degree of interest that the average citizen would take in such a project, because there had never been anything quite like it before. As time went on, however, it became increasingly evident that many people were extremely interested in the development in the Tennessee Valley, and it was necessary to make each decision on the premise that visitors—millions of them—would come, look, and judge by what they saw. Here, then, existed a rare opportunity for a demonstration of what public structures could be—practical, sincere, and beautiful.

Naturally, there were engineering problems to be solved. But the engineers, instead of considering the architect an outsider to be called in to beautify their otherwise efficient solutions, permitted architects to work side by side with them in the development of their designs. As a result—to quote from an article by Mr. F. A. Gutheim in the September 1940 issue of the *Magazine of Art*—architecture and engineering in the Authority's structures "Are more completely integral than they have been at any time since the two professions became separated."

Of course, many elements were subject to architectural control in the interests of better proportion, composition, and the character of the materials used. But it is my opinion that the TVA engineers and architects, with a sympathetic appreciation of each other's problems in the molding and shaping of the basic elements of functional engineering into a general collective unity, have made a real contribution to the importance of collaborative effort in the design of engineering structures. Some of the results of this collaboration are shown in the accompanying photographs. Another TVA photograph appears on the cover of the current issue.

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Multiple-Use Water Projects

TO THE EDITOR: The paper by E. B. Debler on "Multiple-Use Aspects of Irrigation Projects," in the February issue, is a timely contribution to the rather meager fund of concrete knowledge on this subject, which is of such great importance to the arid regions of the nation. It is also an excellent analysis of the present trend to evaluate the economic justification for development of one of our greatest natural resources upon the premise that costs should be shared in proportion to the benefits derived, regardless of the character of the beneficiary.

The people of the arid regions are probably more conscious of such needs than those of the humid regions, since the stability of these areas is primarily dependent upon the fullest possible use of existing water supplies. The author has enumerated the nature of the multiple demands upon water supplies, particularly of the arid West, and has broadly outlined methods by which such demands may, in many instances, be met through a coordination of uses.

One important need in connection with irrigation uses, not mentioned by the author, is that of drainage, which not only permits of an additional beneficial use of the water so recovered, but also may greatly improve the sanitary and healthful conditions of a region.

The paramount demand upon the water supplies of any country is to meet domestic and sanitary needs. This demand must be met irrespective of cost. The next most important requirement is for the production of food supplies. Next in order of importance are the needs for manufacturing, the development of power, transportation, preservation of wild life, and recreation, which are so recognized by the constitution and laws of many of the arid or semi-arid states. Also, with the tremendous development of the resources of the nation, flood control has a vital place.

During earlier periods of development the economic justification for any single-purpose project was determined solely by the estimated ability of the project to repay the cost thereof, together with overhead carrying charges. For those times this principle was sound. However, the tremendous social and industrial development of the country now makes major water projects economically feasible, by including therein a multiplicity of uses.

With the author's conclusion that needs of water for consumptive uses should never be subordinated to uses of a non-consumptive character, such as power development and navigation, the writer is in full accord. The author has illuminated the complexities with which the engineer is confronted in reaching a rational determination as to the nature and number of multiple uses that the supplies from a given source would best serve, and the intricacies involved in a proper evaluation of the same. He has, also, explained the difficulties with which the profession is confronted in attempting to reach sound conclusions, as a result of inadequate factual data, and the impossibility of accurately anticipating trends in natural and economic conditions.

The laws of many of our Western states permit but one use of the water appropriated for any particular purpose and forbid a recapture and re-use of the water except under a new appropriation. While the relative importance of various uses of the water of a stream are well recognized, the problem of combining such uses in a multiple-purpose project under existing laws and constitutional provisions is not susceptible of ready solution. Attempts to coordinate such uses require a vast amount of study by the engineer and possibly equally great effort on the part of the legal profession, a high degree of cooperation between vested interests that may be affected, and in some instances, agreements between the states and the federal government.

M. C. HINDERLIDER, M. Am. Soc. C.E.
State Engineer

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Interpretation of Tests on Silt Samplers

TO THE EDITOR: The article by D. S. Jenkins on "Silt Samplers Compared in Special Tests," in the January issue, was of considerable interest. In testing the accuracy of the various samplers all of them were operated simultaneously in the same river cross section at pre-selected locations and then shifted about according to a pre-arranged design. Each sampler was used to collect 60 samples in this test. The tabulated results are as follows:

SAMPLER	AVERAGE SILT CONCENTRATION IN 60 SAMPLES, PPM
U.S. Geological Survey	9,353
Tennessee Valley Authority	9,350
Tait-Binckley	9,272
Farris	9,254
Eakin	8,943
Average	9,234
Average, omitting Eakin sampler	9,307

It will be noted that each of the first four samplers gave results that are within 0.6% of their average result. Mr. Jenkins states that the Eakin sampler leaked peristently throughout the tests and that this leakage being from the bottom of the sampler may have carried the heavier solids away and thus caused the results to be consistently low. Since this was the case, the results from the Eakin sampler should not be included in any comparisons. The four remaining samplers give results that are essentially equally representative of the silt concentration. Mr. Jenkins concluded from these tests that the Farris sampler gave the most representative results but on the basis of the above analysis it is no better than the U.S. Geological Survey, the TVA, or the Tait-Binckley sampler.

Recent tests made at the University of Iowa show conclusively that the intake of a sampler should allow the silt and water to enter the sampler without a change in direction of flow, unless the silt particles being sampled are all finer than about 0.06 mm. In such fine material a change in the direction of flow seems to make no appreciable difference. Mr. Jenkins' tests were made on fine silt and so verify the latter conclusion. However, when coarser silt is likely to be present, bottle samplers—such as the U.S. Geological Survey and Farris—will collect samples that are appreciably low in silt concentration, since they require a 90-deg change in the direction of flow.

The tests of relative speed and ease of operation made by Mr. Jenkins were unfair to some of the samplers. The operating personnel was apparently unfamiliar with the samplers, and it is obvious that some of them are more complicated than others and so require the development of a sampling technique for best results. It should also be noted that the total time required to collect a number of samples is the true test of speed of sampling. Total time less sampler filling time is of little importance when the river is in flood and samples must be collected. On the basis of total sampling time, the TVA and Tait-Binckley samplers are shown to be superior by Mr. Jenkins' tests.

Although Mr. Jenkins states that the horizontal valves on the TVA sampler probably deflect heavy solids into the mouth of the tube, tests at the University of Iowa have demonstrated that such horizontal valves have no noticeable effect on the silt concentration in the sampler. In theory, I am inclined to agree with Mr. Jenkins' contention that "any sampler which requires transfer of the sample to an auxiliary container is less desirable than the bottle-type sampler from the standpoint of field operation, because of the danger of losing part of the sample on transfer." But a glance at the foregoing tabulation indicates that the TVA sampler apparently did not lose much silt in transferring these 60 samples since the average concentration is higher than that collected by the Farris bottle-type sampler and practically as high as the U.S. Geological Survey bottle-type sampler.

Anyone who has tried to lower a bottle sampler of the U.S. Geological Survey type into a river flowing at 5 to 10 ft per sec or faster will readily agree that there is great uncertainty regarding the depth of the sampler below the water surface as it is carried downstream by the current. To get a fair degree of control heavy weights must be used. Such weights can be handled fairly well with a sounding reel and crane but they tire the field engineers and slow the sampling process. A weighted, streamlined sampler is much more practical.

M. A. CHURCHILL, Jun. Am. Soc. C.E.
Assistant Hydraulic Engineer, Tennessee Valley Authority
Knoxville, Tenn.

More About Mulholland

To the Editor: J. B. Lippincott's lovely story about William Mulholland, which appeared in the February and March issues of Civil Engineering, has no doubt touched a vibrant chord in the heart of many a friend of the great chief. May I ask for a little space for the recital of some incidents in my long acquaintance with Mr. Mulholland? Though in lighter vein, these remarks nevertheless may help to fill in the picture.

It has been brought out that Mulholland's Irish wit often colored his remarks, which were always to the point. During the San Francisco World's Fair in 1915, I met the chief in the Art Palace Annex. It may be recalled that those were the heydays of the cubists, futurists, and post-impressionists, and that the Annex offered a free-for-all opportunity for the display of their art; and a merry exhibit of color and ideas it was. "Mr. Mulholland," I asked, "What do you think of these pictures?" "Well," he replied, "It looks as if they had run Fuller's Paint Factory through a concrete mixer."

The successful completion in 1912 of the aqueduct was widely heralded in the papers, and many were the interviews with the chief engineer. One of the news stories ran about as follows: "Mr. Mulholland, what is your philosophy?" "Always look forward, let the past be the past." "What is your religion?" "The Golden Rule." "And what are your politics?" "Give every man a chance."

In the course of years, I made a number of trips in the company of Mr. Mulholland into the desert areas along the aqueduct. As was his custom, the chief frequently commented on features and natural phenomena that affected the life and safety of the aqueduct. He had a remarkably clear conception of the great story that is written on the face of the desert, in its physiographic features and their causes. The construction of a 250-mile aqueduct across the rough terrain of successive watersheds of dry waste lands, which are subject to cloudbursts, mud flows, frequent temblors, extreme variations in temperature, and other rigors of nature was pioneering work in those days. Unusual problems presented themselves, the solution of which required above all an insight into natural forces and phenomena. That these problems were solved successfully is proved by the relatively few and brief interruptions in the operation of this great conduit.

One ingenious phase of the Owens River project that was part and parcel of Mulholland's original plan has not been generally appreciated, possibly because of its simplicity. It is the utilization of the closed ground-water basin of San Fernando Valley near Los Angeles as terminus of the aqueduct and for long-period storage and regulation of the imported water supplies. This scheme was feasible because the city, by virtue of its Pueblo right to the waters of the Los Angeles River, controls the underflow of the San Fernando Valley, and it was accomplished by applying the surplus water to the irrigation of the valley and by the concomitant capture of the return waters. Its great value was fully proved during the period of drought beginning in 1922.

It was relatively easy to see Mr. Mulholland, even during the busy days of constructing the aqueduct. He never appeared to be in a hurry or bustlingly busy, and he did not trouble himself with details that naturally should fall to subordinates. Friends and the many callers who came for advice were always received with a smile and a measure of patience. However, one day I did notice a fair-sized pasteboard tacked on the wall above his desk with this inscription in neat engineering lettering: "When ye are through pumpin' leave the handle."

A. L. SONDEREGGER, M. Am. Soc. C.E.
Consulting Engineer
Los Angeles, Calif.

Nomenclature for "Four Regimes of Open-Channel Flow"

Dear Sir: The "Four Regimes of Open-Channel Flow," referred to in the article by Messrs. Robertson and Rouse in the March issue, apparently are in dire need of "a local habitation and a name." Since, as the authors point out, there is no nomenclature by which they may be properly delineated, there is no other choice than to devise terms that will clearly define them.

The briefest designation would consist in using the numbers in Fig. 1 to designate the four states of flow. Thus one might write Flow Regime No. 1 meaning tranquil-laminar, and so on. Such designations, however, would be meaningless without a key, and such a key is not always at hand.

These four regimes have two critical states as their limiting boundaries. The Froude limit is quite stable, being defined by the condition that $V^2 = 2gy$. The Reynolds limit however is a broad zone; and while the authors have indicated $Vy/\nu = 500$ as the limit, it probably varies between 400 and 2,000 or perhaps more. In the hydraulic laboratory at Oregon State College, rapid-laminar flow has actually been observed in an open channel where Vy/ν approaches 2,000 and the upper limit had not been reached.

Nevertheless such a dividing zone does exist, beyond the upper boundary of which the flow is always turbulent and below which it is always laminar. We may therefore define the four regimes completely by the following terms, in which R represents the Reynolds critical and B the Belanger critical:

sub R sub B would stand for tranquil-laminar
sub R super B would stand for rapid-laminar
super R sub B would stand for tranquil-turbulent
super R super B would stand for rapid-turbulent

These designations apply to velocities and not to depths, and are therefore characteristics of flow. Thus quite briefly are the four flow regimes for open channels completely and accurately designated without the use of anomalous terms.

J. C. STEVENS, M. Am. Soc. C.E.
Portland, Ore.

The Engineer and Esthetic Design

TO THE EDITOR: In his article, "Esthetic Responsibilities of the Engineer," in the March issue, Mr. Lewis has discussed the essentials of education and the efforts that engineers should make to produce works of notable esthetic character. The growing appreciation of the public for beautiful things is exerting an influence upon engineering thought, which is being reflected in more beautiful structures. People demand pleasing color and form in automobiles, railroad trains, household utensils, garden tools, and countless other articles. This is a very healthy trend, and we should be grateful for it because it denotes higher culture and a greater capacity for real appreciation.

Form is frequently the underlying element in beautiful structures, and therein lies the great opportunity of the engineer. In fact, the engineer's opportunity as well as his reponsibility in the creation of esthetic structures must be emphasized.

Prehistoric bridges were crude structures, but as the principles of masonry design became better understood more beautiful structures resulted. The same progress has been made in concrete and steel, and within one generation concrete highway spans have progressed from unsightly makeshifts to almost universally esthetic forms. Greater engineering knowledge has produced structures that derive their beauty from a new understanding of design principles rather than from ornamentation.

The skillful fitting of Boulder Dam into the cliffs of the Colorado River is esthetically satisfying and a contribution to the art of the nation. The skillful placing and handling of the appurtenances of the dam and the application of pleasing architectural treatment both to the exterior and to the tunnels and power houses, add to the beauty of the structure and the enjoyment of many. The engineers on this structure and many others have been alive to their esthetic opportunities and responsibilities and have not sacrificed sound engineering design to attain these ends.

Highway development has passed through a transition period and, in many parts of the country, has risen to a high plane of esthetic attainment. Older roadways, often little more than railroad grades, have been succeeded by main highways and secondary roads, which follow attractive alinements, skillfully adjusted to grades, and have side slopes artistically blended into the surrounding terrain. This improvement has come entirely through realization that such design makes highways more efficient for the movement of traffic and safer for those using the roads.

In the more prosaic engineering fields the trend towards esthetic design is observable. Sewage disposal plants, which were formerly hidden from view and regarded as necessary evils, are, in many cases, subjected to landscape treatment and have become an attractive feature of the community. Industrial plants frequently supplement sound engineering design of buildings with architectural and landscape treatment that makes them of esthetic as well as economic value to the city. Railroad terminals, formerly noted for their dinginess, have been greatly improved in design, and the union station in Cincinnati presents one of the world's finest examples of the result of the esthetic collaboration of the engineering and related professions.

One of the most encouraging evidences of the growth of esthetic responsibility among engineers is the increasing desire of many engineers to cooperate with the architect, the landscape architect, the painter, the sculptor, and others whose fields have ordinarily been regarded as more closely associated with the arts. This cooperation has in every instance been of value, and each participant has gained a better understanding of the field of the other. This change has been brought about by a variety of educational efforts and experiences and, as Mr. Lewis points out, such efforts should be strengthened in all of our engineering schools.

L. V. SHERIDAN, M. Am. Soc. C.E.

Indianapolis, Ind.

Tests on Open-Channel Flow

TO THE EDITOR: We have read with much interest the paper, "On thh Four Regimes of Open-Channel Flow" by Messrs. Robertson and Rouse in the March issue. We also have noted the existence of "rapid laminar" flow in our experiments on the hydraulics of very small streams.

In our experiments we have used a triangular channel with a 90-deg included angle, made of pyralin, and a semicircular galvanized iron channel 6 in. in diameter. In both cases we have found laminar flow, shown by the persistence of a filament of colo. throughout the 20-ft length of flume, at Reynolds numbers considerably above the lower critical value of 500, using the hydraulic radius as the length factor.

In a number of cases we have been able to change the flow back and forth between turbulent and laminar at will, with the same bottom slope and quantity of flow. In each case the Reynolds number has been larger for the laminar flow, because of the higher velocity, than for the turbulent flow.

The accompanying Table I shows the data for typical runs in these channels. It will be noted that in the two runs in the triangular channel, the energy slope for laminar flow is quite close to the bottom slope thus indicating uniform flow, whereas in the semicircular flume the turbulent run approximates the uniform condition. In each of the other cases the energy slope is flatter than the bottom slope of the channel. In each case the laminar flow took place at a depth below the critical and was "shooting" or "rapid." In the runs in the triangular channel the turbulent flow was at greater than critical depth and thus was "streaming" or "tranquil," whereas in the semicircular channel the flow was "shooting" or "rapid."

These six runs therefore include examples of three of the four regimes discussed by Messrs. Robertson and Rouse. The accompanying photograph shows the color filament in run J-special, taken near the entrance to the flume. The color filament continued the full length of the 20 ft of flume. Although it is not shown in the photograph, a hydraulic jump was developed in this flow whenever the flow was obstructed.

JOHN M. HALEY *and*
M. R. LEWIS,
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RAPID LAMINAR FLOW SHOWN BY COLOR FILAMENT

TABLE I. TYPICAL FLOW DATA

Channel	Character of Flow	Run Number	Quantity Cu Ft per Sec	Depth of Flow in Ft	Mean Velocity Ft per Sec	Reynolds Number	Belanger's Critical Depth in Ft	Slope: Energy	Slope: Bottom
Triangular	Rapid laminar	A-10-3	0.00250	0.0505	0.987	1,248	0.0521	0.00318	0.00307
Triangular	Tranquil turbulent	A-10-3a	0.00250	0.0645	0.607	980	0.0521	0.00253	0.00307
Triangular	Rapid laminar	A-11-1	0.00319	0.0551	1.053	1,406	0.0572	0.00303	0.00292
Triangular	Tranquil turbulent	A-11-1a	0.00319	0.0693	0.666	1,121	0.0572	0.00248	0.00292
Semicircular	Rapid laminar	J-4-3	0.00741	0.0245	1.95	2,330	0.0415	0.01255	0.0149
Semicircular	Rapid turbulent	J-4-4	0.00741	0.0303	1.40	2,120	0.0415	0.01481	0.0149
Semicircular	Rapid laminar	J-special	0.00437	0.0197	1.68	1,641	0.0314	0.01296	0.0149

SOCIETY AFFAIRS

Official and Semi-Official

Adequacy of the Supply of Civil Engineers for Defense

From an Address Before the Metropolitan Section by Walter E. Jessup, Field Secretary of the Society

To arrive at an answer to the question implied in the title requires an indirect approach. There cannot be a categorical answer—"Yes, we do have enough civil engineers," or "No, we do not have enough civil engineers to carry out the national defense program."

Civil engineers are adaptable individuals. A structural engineer competent in building or in bridge design, can adapt himself to airplane wing stress analysis. Many structural engineers have transferred to this kind of work to supply the great demand there. The entire civil engineering graduating class of a large Mid-Western college took employment last June in the aviation industry. A structural engineer also can adapt himself to the design of ship hulls and many have answered the call to assist in this very important work. The Maritime Commission alone has a 6-billion-dollar program of shipyard and cargo ship construction in the making.

Construction Volume as an Index to Employment of Civil Engineers

By the nature of their training civil engineers have from time immemorial been charged with the design and supervision of construction work. When the volume of construction is low, many civil engineers are out of employment. When the volume is great, whether the construction be for public works or for private works or for defense purposes, civil engineers are greatly in demand. That is to say, the total annual construction volume in the United States may be taken as one index of this demand. Whether or not engineers are responsible for these economic cycles is another consideration, but there is no doubt that civil engineers are affected by them.

Courtesy U.S. Steel Corp.

Night Shifts Become the Rule as Steel Production Reaches 98% Capacity

South Works of the Carnegie-Illinois Steel Corporation, Chicago

According to studies of construction activity in the United States made by the Department of Commerce, the construction volume reached an all-time peak of nearly 11 billion dollars in each of the years 1926 and 1927. Approximately two-thirds of this was for private construction. Civil engineers were fully employed during that period, but the supply of them seemed to be adequate. After this peak began the great depression of 1933. From 1929 to 1933 the annual volume of construction dropped from a high of 10 billion dollars to a low of but $2^1/_2$ billion dollars. Thousands of engineers were out of work or on relief until the program of "Public Works Construction for Relief of Unemployment" got into full swing. Since 1933 the stimulation of an increasing volume of public works construction has steadily raised the volume of both public and private activity to 7 billion dollars for 1939. The further stimulation of the defense program in June 1940, raised the construction volume to $8^1/_2$ billion dollars during that year. Huge appropriations by Congress will further raise the figure for 1941 to an estimated 11 billions. In this year therefore we can expect a construction volume as great as in the peak period of 1926 and 1927.

As there appeared to be enough civil engineers for that peak, we might assume there there are enough for our present peak, but let us examine the supply. Is the supply the same as then?

Enrolments and Graduations in Civil Engineering

The economic cycles that affect construction appear to influence enrolments in engineering schools and in the particular fields of engineering chosen by the students. In the school year 1930–1931, 145 engineering schools in the United States reported to the Society for the Promotion of Engineering Education that 73,000 students were enrolled. By 1935–1936 this total enrolment had dropped to 58,000 students, but since that year has rather sharply risen to a 1940–1941 enrolment reported by 155 schools of 97,000 engineering students. The enrolment of civil engineers expressed as a percentage of all engineering undergraduates has been declining steadily since 1925–1926, when they composed 22% of the total, to 11% during this current school year. That is to say, only 10,000 out of 97,000 engineering students are now taking civil engineering.

In June 12,000 to 13,000 engineers of all kinds will receive their first degrees, but there are fewer civil engineers this year, and for the past five or six years there have been fewer civil engineers than were graduated in 1927–1928. While the total number of engineer graduates has increased, the number of civil engineer graduates has declined. Not only is this so, but it is anticipated that every engineering student who has completed his R.O.T.C. course will on graduation become a Second Lieutenant in the Reserve Corps, will be called for a year of active duty, and will thus be unavailable for the year's construction program. At least 1,000 of the engineering graduates of June 1941 are expected to enter the Corps of Engineers. Others will be called by the Selective Service and by the Aviation Corps of both the Army and the Navy. Deducting these from the total graduates, it is estimated that only 8,000 of this year's graduates will be available for necessary replacement in construction and in industry; and that not more than 1,000 of these will be civil engineers. Thus the effective supply of civil engineering graduates will be less in 1941 than it was in 1927.

Other Depletions of the Supply

There are other factors reducing the present supply of civil engineers available for construction. Already 2,000 older Engineer Reserve Officers have been called to active duty and it is anticipated that another thousand will be called during this year. Some of these have World War No. 1 experience; the others are graduates of R.O.T.C. courses since 1917. These officers will not be available for their normal function of design and supervision of construction. As mentioned previously, ship and shipyard construction is diverting structural engineers to this field of endeavor. Bridge designers and fabricators are turning their man power and plant facilities toward ship construction.

Dean R. A. Seaton, Director of Engineering Defense Training (E.D.T.), in the U.S. Department of Education, said recently that one out of every ten employees in the aviation industry should be an engineer. Of the 7,200 enrolled in the aeronautical engineering courses of the E.D.T. program, 30% are studying structures. Of the 2,000 enrolled in marine engineering and naval architectural courses, nearly one-half are studying hulls, which are, of course, allied to structural engineering.

EVIDENCES OF SHORTAGE

The Founder Societies employment offices, known as Engineering Societies Personnel Service, has offices in New York, Chicago, Detroit, and San Francisco. Their reports for March show requests for at least twice as many civil engineers as were placed during that period. All the offices report a supply smaller than the demand, and at Chicago the list of availables is practically exhausted.

The U. S. Civil Service is swamped with requests for technical men that it cannot fill from its list of eligibles. The written examinations for Junior Engineer and Assistant Engineer have been discontinued. A graduate engineer from a recognized college at the time of his graduation may be placed on the list of eligible Junior Engineers after an unassembled examination of his application and experience record. Civil Service is finding it necessary to certify individuals specifically requested by government departments because of its inability to find men on its own lists. Various government departments, such as War, Navy, Office of Production Management, and the Federal Works Agency, are seeking the assistance of Engineering Societies Personnel Service in locating men.

DEMANDS OF THE DEFENSE PROGRAM

Appropriations by Congress to date have had two broad purposes: (1) to increase the size of the Navy by 80% in order to create what is known as a two-ocean Navy, and (2) the housing, training, and equipping of an army of 1,400,000 men. Specifically the work involves air fields and hangars, cantonments, defense housing for families of enlisted men and defense factory workmen, island bases both military and naval, a strategic road net, access roads to cantonments and factories, ordnance and munitions plants, storage facilities, shipyards, navy shore facilities, power plants, hospitals, and naval bases. For the Army and Navy and other defense agencies, the construction work involved in these categories approximates $3^1/_2$ billion dollars.

Although Congress has made appropriations and has authorized contract obligations totaling nearly 40 billion dollars, disbursements of but 10% of this amount have been made to date; that is, about 4 billion dollars. This would indicate that the defense construction program is not being handicapped by lack of funds, but rather by the capacity and ability of the country to produce the requirements.

Although there appears to be need for additional technical assistance in turning out this program, other bottlenecks will be reached before the supply of technical skill has been exhausted—the bottlenecks of labor and priorities of materials. These may require the diversion of strategic materials from normal peacetime operations to the defense program and result in the restriction of normal construction. For example, only one-quarter of the work being done by WPA at the present time is directed toward the defense program.

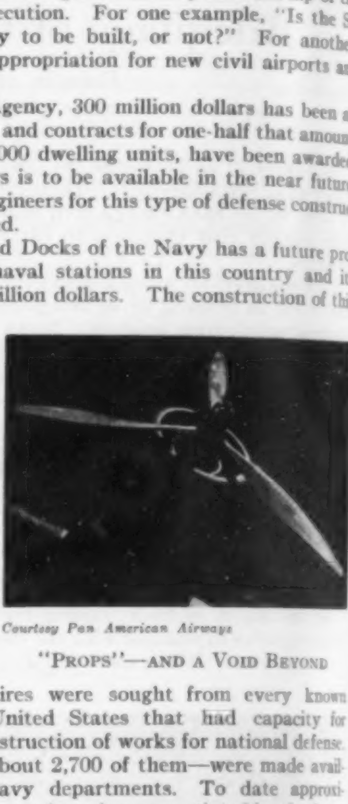
The peak of demand for men by the Construction Quartermaster's $1^1/_4$-billion-dollar program was reached in February this year when the total employment reached nearly $^1/_2$ million, 460,000 of whom were on the contractor's payroll, 25,000 on the government payroll, and 9,000 employed by the engineering firms engaged to produce the plans and supervise the construction on a cost-plus-fixed-fee basis. The demand for civil engineers since that date has eased off and the last barracks for our 1,400,000-man army are expected to be ready by July 1 this year.

Congress has not indicated how much larger our army is to be, although there is persistent talk of authorization of plants to provide equipment and ordnance for an army of from two to four million men. Many informed persons believe that the peak of cantonment construction has been reached and that therefore the peak rate established in February could be continued indefinitely with the engineers available.

The peak of demand for men by the Corps of Engineers on its $^3/_4$-billion-dollar program of airport and island-base construction is expected in about two months. The civilian engineer staff of the U.S. Engineer Department, normally employed on river and harbor work, has been diverted in part to the defense program. About 5,000 civilian engineers compose this staff, and the Corps of Engineers anticipates that additional appropriations by Congress probably will not materially increase that number. There is still the uncertainty of what Congress will drop into the lap of the Chief of Engineers for execution. For one example, "Is the St. Lawrence River Waterway to be built, or not?" For another, "How much will be the appropriation for new civil airports and Army air bases?"

In the Federal Works Agency, 300 million dollars has been allocated to defense housing, and contracts for one-half that amount, for the construction of 45,000 dwelling units, have been awarded. Another 150 million dollars is to be available in the near future. The peak of demand for engineers for this type of defense construction has about been reached.

The Bureau of Yards and Docks of the Navy has a future program of construction of naval stations in this country and its possessions of about 350 million dollars. The construction of this work is to be handled on a cost-plus-fixed-fee basis. Design and supervision is to be handled jointly by the engineer's staff of the Civil Engineer Corps of the Navy and by the engineering firms engaged for the purpose.



Courtesy Pan American Airways

"PROPS"—AND A VOID BEYOND

Last fall, through the efforts of the Society, the National Committee on Construction Preparedness was formed with Secretary Seabury as chairman. Questionnaires were sought from every known engineering firm in the United States that had capacity for design or supervision of construction of works for national defense. All these questionnaires—about 2,700 of them—were made available to the Army and Navy departments. To date approximately 100 engineering contracts have been negotiated by the Army and 125 by the Navy. Evidently the talents of at least 2,000 firms are still available to assist in carrying out any expansion of the program.

The Engineer Defense Training Program has 80,000 engineers enrolled in it—engineers who are largely already employed and who wish to improve their capacity for the tasks they are doing. Less than 10% of those enrolled are taking courses in civil engineering. When the factories and facilities are built by the civil engineers, the mechanical and industrial engineers will man the plants to produce the defense goods and equipment needed. When the cantonments, roads, and public utilities are constructed for the camps and communities required by the defense program, there will be less demand for civil engineers.

To summarize: The anticipated volume of construction for the year 1941 is no greater than the peak in 1927. However, money bought about 20% more construction in 1927 than it does today, so that our actual peak of construction volume is probably less than it was in 1927. The combined ability of the civil engineering profession and the construction industry successfully handled the peak of 1927, and I believe it can handle this one, though fewer civil engineers seem to be available because fewer have been graduated in recent years and more are in military service.

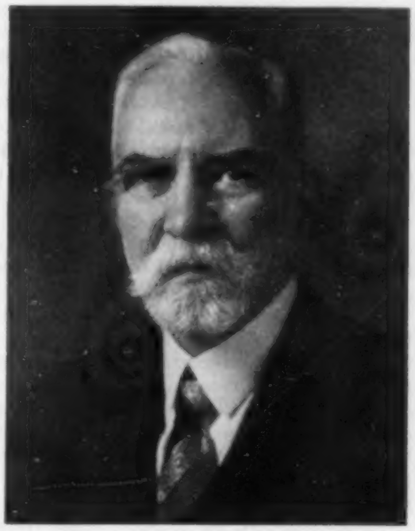
The immediate need for technical assistants for civil engineering work can be supplied by the Engineer Defense Training Program, and as a profession we should continue to stress quality rather than quantity in our civil engineering graduates. We should not permit our civil engineering students to be selected for training before they complete their courses, or allow recent graduates to be drafted for military service where their specific talents may be lost when that talent is badly needed for defense. By curtailing a sufficient amount of non-defense work, enough talent can be diverted to handle all essential defense construction. I have the utmost confidence in the ability of the profession to arrange its tasks, whether public or private, whether of non-defense or defense nature, so that our national defense program will not be handicapped.

Otis E. Hovey, Society Treasurer

Born April 9, 1864, Died April 15, 1941

After a short illness, Otis E. Hovey, Honorary Member of the Society, died at Doctors' Hospital, New York, N.Y., on April 15. He was a few days over 77 years of age. His death has deprived many engineers of a true and trusted friend.

Over a long and successful life, he proved himself a stalwart gentleman, a distinguished citizen, and an outstanding engineer. Born in northern Vermont, he had a rural upbringing. His father encouraged his interest in mathematics and in pursuit of this interest he attended nearby Dartmouth College, where he graduated as valedictorian of his class in 1885. A few years later he received the degree of civil engineer from the Thayer School of Civil Engineering. In later life he was the recipient of honorary doctorates from Dartmouth and from Clarkson College.



Otis E. Hovey, Hon. M. Am. Soc. C.E.

His early work was in railroading and in structural steel drafting and design. For one year he was instructor in civil engineering at Washington University in St. Louis, and had charge of the University testing laboratory. Then followed a fruitful six years as assistant to George S. Morison, Past-President of the Society, on notable bridge structures in the Middle West. Beginning in 1896 and for the remainder of his active life, he was with first the Union Bridge and later the American Bridge Company in Pencoyd and New York. From 1907 onward he was assistant chief engineer in the New York Office.

In his work with the American Bridge Company, many monumental structures came under his direction. In particular he demonstrated exceptional ability in the design and construction of movable bridges, a subject which he later covered in a two-volume standard engineering reference work. He also developed and patented improvements to heavy derricks and turntables for locomotives. For a few years before his retirement from the company in 1934 his title was consulting engineer.

Thereafter he opened a consulting office, which he maintained until his death. Beginning in 1937 he served as Director for the Engineering Foundation, to which he devoted a great deal of time, with offices in the Engineering Societies Building. He never lost his interest in educational and research problems. For 34 years he was a member of the board of overseers of the Thayer School of Civil Engineering, Dartmouth College. He also lectured at Yale and Princeton universities.

In his technical activities, he was a member of many societies, including the American Society of Mechanical Engineers, American Society for Testing Materials, American Welding Society, American Railway Engineering Association, American Institute of Consulting Engineers, and others. His primary interest, however, was with the Society. As a member of the special committee on specifications for bridge design and construction, he participated in two extensive final reports, that on steel railway bridge superstructure in 1922, and that on steel highway bridge superstructure in 1924. He was a frequent and valuable consultant to the Society's Committee on Publications.

But perhaps his greatest contribution to the Society was as Treasurer. He held that office continuously from 1921 until his death. He was punctilious in the duties involved. He was a frequent attender of Society meetings, where his tall and distinguished appearance made him a marked figure. Through his important work with Engineering Foundation, he was a benefactor of all branches of engineering.

To Mrs. Hovey, to his son, Otis W. Hovey, an Associate Member, and to his daughter, Mrs. Ellen Hovey Davis, the sympathy of the Society members will go. Those attending the Denver Convention of the Society last July will remember as one of its outstanding features the delightful flute solo that Dr. Hovey gave, accompanied by his daughter. Through all the years he maintained his love of music and was particularly adept with the flute. During college he was chapel organist.

Many engineers attended his funeral at the Central Presbyterian Church in New York on Wednesday, April 16. He was an elder of that congregation. The Society's Board of Direction, the Headquarters Staff, the governing boards of Engineering Foundation and the Engineering Societies Library, and his former associates at the American Bridge Company, all brought their silent tribute to this service.

The stature of Otis E. Hovey was summed up by his classmate, John B. Brooks, Assoc. M. Am. Soc. C.E., president emeritus of Clarkson College, in introducing this eminent engineer for bestowal of Honorary Membership in the Society. Dr. Brooks aptly described him as a man of innate wealth—"a wealth of character as solid as his native hills; a wealth of ancestry that with others made our early history what it is; a wealth of local and family traditions of honor and industry; a wealth of appreciation of what is fine and beautiful in art and in nature; and a wealth of mentality and ingenuity worthy of his pioneer forebears."

Defense Notes

The Fourth Supplemental Appropriation Bill, passed by Congress on March 13, provided an appropriation of $15,000,000 for preliminary surveys, plans and estimates of cantonments. Under-Secretary of War, Robert T. Patterson, has announced that although Congress has not authorized any additions to the 1,400,000-man Army, the War Department is making plans for 28 more large camps for the accommodation of approximately 1,000,000 more men.

With camp sites tentatively selected and detailed plans and specifications for these big cantonments completed, it will be practicable for the War Department to award construction contracts on a competitive bid basis. This move is in an effort to save time and money over the current cost-plus-fixed-fee basis, where construction has been begun at the same time detailed plans were started.

The War Department is not requesting authority for added Army strength or for funds to construct these camps now.

* * * *

The Bureau of Yards and Docks of the Navy Department has announced in detail its $350,000,000 program of Naval Public Works construction as authorized by the Fourth and the Fifth National Defense Appropriation Act of 1941 and the Naval Appropriation Act of 1942. The construction anticipated involves underground fuel storage facilities, air station and aviation training facilities, barracks, supply and ammunition storage facilities, dredging, breakwaters, piers, graving docks, bomb-proof shelters, fleet anchorages, and fleet operation facilities. These projects are located at shore points in the United States and on the island possessions.

The selection of contractors, or groups of contractors, engineers and architects for these projects is to be made from a list of reputable and qualified individuals or firms, regularly engaged in work comparable in magnitude and character to that to be done by the Navy. Congress has authorized this work to be done on a cost-plus-fixed-fee basis.

The Chief of the Bureau of Yards and Docks, Navy Building, Washington, D.C., will furnish on request any detailed information that is not of a confidential nature. Those interested in participating in the work should file complete data on their qualifications, performance record, present volume of work and names of those for whom the work has been done, with the Contact and Liaison Section of the Bureau of Yards and Docks.

* * * *

The Fifth Supplemental Defense Appropriation Act of 1942 became law in April. It appropriated $4,390,000,000 for several purposes, mostly for the Army, as follows: first, to build productive capacity to produce the equipment and armament for an army of

4,000,000 men; second, to build 3,600 bombing planes for the Army; and third, to speed up the Air Corps training program so that it can turn out 30,000 proficient air pilots annually.

* * * *

The Construction Division of the Quartermaster Corps of the Army recently has instituted a policy that does not permit engineers who are members of firms holding contracts with the Construction Division to be retained as consultants to the Division, or to be employed in the Division. This has resulted in several resignations and replacements in the Civil Engineering Unit. Earnest Boyce, M. Am. Soc. C.E., chief engineer of the Kansas State Board of Health, is advising on cantonment water supply problems formerly handled by E. B. Black, M. Am. Soc. C.E., of the Kansas City firm of Black and Veatch. A. M. Rawn, M. Am. Soc. C.E., chief engineer of the Los Angeles County Sanitation District, is advising on sewerage and sewage treatment problems formerly handled by Samuel A. Greeley and Thomas M. Niles, Members, Am. Soc. C.E., of the Chicago firm of Greeley and Hansen. Advising the Civil Engineering Unit on special structures is Leonard C. Urquhart, M. Am. Soc. C.E., of Cornell University. On the Construction Advisory Committee to the Division, Richard H. Tatlow, Assoc. M. Am. Soc. C.E., has been appointed to fill the vacancy created by the resignation of Francis Blossom, M. Am. Soc. C.E., of the New York firm of Sanderson and Porter. Enoch R. Needles, M. Am. Soc. C.E., of the firm of Howard, Needles, Tammen and Bergendorf, who has been serving as Zone Engineer of Zone II, New York, for the Construction Division, has resigned.

* * * *

The National Resources Planning Board has prepared and recently recommended to the President a six-year post-emergency adjustment program of Public Works construction in accordance with the provisions of the Federal Employment Stabilization Act. The six-year program recommended consists of a reservoir of long-range projects originated by federal construction agencies from which projects can be selected by Congress or the President appropriate to the needs of the country at the time. The Board recommends the establishment of a revolving fund to be administered by the President for making preliminary investigations, surveys, engineering plans, and specifications on selected projects with funds allocated to federal and non-federal agencies. The revolving fund would be reimbursed as a part of the cost of the construction of the projects when they are built.

* * * *

Howard O. Hunter, Acting Commissioner, reports that the WPA airport construction program now includes $150,000,000 worth of work at 350 sites certified by the War and Navy Departments as important to the nation's defense. Expansion of this activity is illustrated by the rate of approvals, which has been four times as great since the defense preparedness program began last summer as during the past fiscal year.

* * * *

More than 20,000 men sent to defense training schools by the WPA have secured jobs in private industry. Of the total of 70,900 trainees who have gone to classes since July 1941, when the courses were started, 30,000 men are still enrolled, while over 21,000 men have completed training. Out of the group no longer in training, more than 20,000 are now in private employment.

* * * *

Crews of the WPA at work on coastal and harbor defenses on the Oregon side of the Columbia River are relocating U.S. Highway 30, which provides access to the Naval Air Station at Tongue Point, a reach of land that protects the wharves of Astoria from the sweep of the Pacific Ocean. The Astoria municipal airport is being improved. Workers are constructing a roadway between Camp Clatsop and Fort Stevens, the Army Post on the Point. At Camp Clatsop, the water system is being extended, training grounds are being built, and buildings repaired. Up the river, runways and aprons and other field facilities and flood-control levees are being installed at the Portland municipal airport.

The Wolf Creek Highway work, extending the road system in four counties in the northwest corner of the state, is approximately 65% complete. In this strategic area, bounded by the Pacific Ocean and the Columbia River, more than $6,000,000 of WPA and sponsors' funds have been spent on roadways to aid motorized movements. The work has been certified by the War Department as being essential to national defense.

Accrediting and Recognition Stressed in Annual Report of E.C.P.D.

ENGINEERING, in many and obvious ways, is growing as a profession. The quality of that growth is largely governed by activities in accrediting curricula, in improving the admission of suitable students to the profession, and in securing the proper appreciation of all that it means to be an engineer. These activities are described in the Eighth Annual Report of the Engineers' Council for Professional Development, just published. Also listed in this report are the 125 institutions in the United States (and Alaska) that have been accredited by E.C.P.D.

The chairman of E.C.P.D., John P. H. Perry, M. Am. Soc. C.E., of New York City, records not alone the affiliation of the Engineering Institute of Canada, in October 1940 with E.C.P.D., but stresses the remarkable progress in accrediting engineering curricula. He reports also the petition from a group of technical institutes that some such plan of accrediting be evolved by E.C.P.D. for the technical institutes of the country, thus giving more effective recognition to their sphere in technical education.

The Committee on Student Selection and Guidance, Dean Emeritus R. L. Sackett, M. Am. Soc. C.E., of Pennsylvania State College, chairman, reports further progress in the study of aptitude tests, and especially advances in the promotion of proper selection of engineering as a career by high school boys. This committee's report contains excerpts from summaries of activities submitted by local groups of engineers, in New York, Omaha, Detroit, Iowa, and Canada, whose aim was not to recruit to engineering but to give boys of high school age an opportunity to learn the qualities and aptitudes essential to success. Thus, those with decided engineering talent will continue in their ambitions for this field while those without sufficient aptitude will not undertake a career in engineering if they will be more likely to succeed elsewhere.

Dean A. A. Potter of Purdue University, for the Committee on Engineering Schools, discusses the problems of accrediting and gives statistics on the subject since the initiation of the accrediting program. Included with this report is the latest list of accredited engineering curricula.

The Committee on Professional Training, Dean O. W. Eshbach of Northwestern University, chairman, reports further efforts to discover what is being done by and for junior engineers in their immediate post-graduation period, and includes as an appendix a questionnaire used to gather information on this subject. This will be used, then, as the basis of a program to be developed for use among the various organizations.

The Committee on Professional Recognition, Prof. Emeritus Charles F. Scott of Yale University, chairman, probes the matter of engineering as a profession, and an appreciation of it as such. He strongly urges the various constituent organizations of E.C.P.D. to encourage emphasis on ethics, the teaching of ethics, and the professional spirit among engineering students, in order that they may acquire a full conception of the profession as early as possible.

Founded in 1932, E.C.P.D. is an organization representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, Society for the Promotion of Engineering Education, National Council of State Boards of Engineering Examiners, and the Engineering Institute of Canada. The purpose of E.C.P.D. is to enhance the professional status of the engineer. Its Eighth Annual Report evidences definite progress toward this objective.

Freeman Scholarship Not to Be Offered in 1941

PLANS for the award of the John R. Freeman Scholarship during 1941 have been tentatively abandoned by the committee in charge. It is considered that the hazard of possible draft calls for the young men concerned makes the granting of the scholarship inadvisable at this time. However, if conditions should change unexpectedly, or if the award is to be made in 1942, appropriate announcement will be made.

Standards of Professional Conduct—a Manual of Engineering Practice

A MORE FITTING subject for a Manual of Engineering Practice can scarcely be imagined than that of "Standards of Professional Relations and Conduct," Manual No. 21, by Daniel W. Mead, Past-President and Hon. M. Am. Soc. C.E. The meticulous care taken to make this work expressive of the best thought in the Society is characteristic of the preparation of the Society's manuals.

Although it appears under the authorship of a one-man committee, the manual is an expression of authority in more ways than one. The study was undertaken as a result of Board action, and Dr. Mead was assigned to the task because of his widely recognized knowledge and interest in the subject. The resulting paper was first published in PROCEEDINGS for January 1940. It was discussed by the profession for many months, and the author's closure appeared in PROCEEDINGS the following November. The complete paper will be published in the next TRANSACTIONS, with full discussion, in accord with customary practice.

With the guidance of comments presented in discussion, the original paper has been remodeled into Manual 21. The price of the manual is 50 cents (25 cents to members). Copies in quantity lots, for free distribution, may be secured by members of the Society and students affiliated with Student Chapters at the following rates: 10 copies, $2.50; 25 copies, $6.00; 100 copies, $12.50; 200 copies, $18.00. Obviously, the Society would not permit distribution for resale.

Ordinarily a manual is distributed to each member. In the present case, each member has already received the paper and discussions in PROCEEDINGS and will receive the complete paper in TRANSACTIONS. Therefore only a limited number of copies of Manual 21 have been placed in stock, to supply sale demands.

Field of Soil Mechanics Outlined by Committee of Hawaii Section

TO ACQUAINT the general membership of the Hawaii Section with the scope of soil mechanics activities, the chairman of the local committee on soil mechanics, Carl B. Andrews, several months ago issued a clear statement. Excerpts from it are worth repeating:

Soil mechanics deals with the behavior of soils under loadings. The subject divides itself into several fields, among which are, first, the supporting values of soils (foundation problems); second, the stability of slopes against sliding, which includes the pressure against retaining walls; third, the stability of soils on which road pavements are laid. These fields overlap somewhat, and there are other soil phenomena, such as subsidences and fluidization of soils, which are not included definitely in any one of the above groups.

One of the earliest problems faced by workers in soil mechanics was that of the classification of soils. This problem has been fairly well solved, on the basis of certain laboratory tests which have been devised. The usual tests of soils, made for engineering purposes, include tests for compressibility, permeability, water content in the natural state, the liquid, plastic, and shrinkage limits, the grain-size distribution, the specific gravity, the slaking time, and perhaps some others, depending on the nature of the soil.

In order that the classification of a soil may have some value in future engineering work, there should also be observations of the behavior of the soil under known stress conditions. When this has been learned, the behavior of the same or a similar soil under other stress conditions not differing too widely from those previously obtaining, may be reasonably forecast.

In work in which the supporting value of the soil is under investigation, the settlement of the structure would be observed. Such settlements may be very slight and hence not easy to detect; also it must be known that the reference bench mark does not itself change. "Ground pegs" are devices built into a foundation for the purpose of detecting relative movements between the bottom of the foundation and underlying strata at different depths, and these may be used under conditions where ordinary leveling would not be satisfactory. For either slab or pile foundations, a knowledge of the nature and thickness of the underlying strata is of value.

Settlements are due somewhat, at times, to lateral flow of the loaded soil. Such movements are difficult to measure directly. Sometimes movements of retaining walls may be measured, but these are generally very small, unless failure is impending, and special apparatus is required for their determination.

In cases of earth slides, usually the movements previous to failure is negligible; the failure occurs with little or no warning and quite suddenly. Field data which would be valuable for future reference include the measurement of the shape of the curve of rupture after failure, together with a drawing showing the cross section of the embankment before rupture. Specimens of the soil should be obtained, which may be subjected to the usual physical tests. If small slides have occurred in a typical soil, such data would be of value in forecasting the behavior of the same soil in larger embankments.

In the case of soils which support road pavements, there is likely to be some organic matter in the surface soil. A small percentage of organic matter will modify the physical characteristics of a soil so greatly that the usual physical tests of soils are not of great value. The work with surface soils in connection with road construction has been largely along the line of stabilizing the soil by the addition of chemicals or binders of different kinds. The observational data take the form of written descriptions of the behavior of the pavement under traffic, rather than a set of measurements.

Undergraduate Summer Placement

RECOGNIZING the importance of practical summer work to supplement university training, the San Francisco Section has again appointed a committee to help civil engineering undergraduates locate summer employment. The committee has circularized all members of the Section in order to canvass every possible opening.

Four direct questions are asked by the committee. Because of their possible bearing on action contemplated by other Sections, these questions are printed here:

1. Is there a possibility that you will be able to place some summer employees? If so, how many?
2. Would you prefer to interview men from California, Santa Clara, or Stanford?
3. What will be the nature of the work? For example, structural draftsman, miscellaneous office work, laborer, timekeeper, skilled laborer (name trade), etc.
4. What possible prospects for summer jobs have come to your attention? Give names and addresses of prospective employers and nature of the work.

Progress Indicated on Air Entrainment Study—J. Waldo Smith Fellowship

EXPERIMENTS on air entrainment in a 6-in. transparent pipe are well under way at the Iowa Institute of Hydraulic Research. J. M. Robertson, present holder of the J. Waldo Smith Fellowship, reports that experimental data have been obtained on the effects of the hydraulic jump in the partly full pipe in a horizontal position for a considerable range of depth and velocity.

Influence of simple air-water friction on air entrainment has also been investigated in the partly full pipe. Effects of changes in pipe slope will probably be considered next. Unless unexpected difficulty is encountered in correlating the results of these experiments, they should have important implications in the design of outlet works, penstocks, and possibly even spillways and steep canals.

The Fellowship has been awarded to Mr. Robertson for another year, 1941–1942, in order that these experiments may be continued.

Spring Meeting of Mid-South Section

ATTENTION of members in the southern part of the country is called to the annual spring meeting of the Mid-South Section, which will be held at the Marion Hotel in Little Rock, Ark., on May 5 and 6. The varied technical program will include the presentation of papers on the construction of Camp Robinson, supplemented by a conducted tour of the camp. There will be a joint luncheon with the Little Rock Engineers Club Monday noon and a banquet Monday night.

Selective Service Deferment for Students

LOCAL DRAFT BOARDS have been urged by Deputy Director Louis B. Hershey of the Selective Service System, to give special consideration for deferment to students enrolled in professional, scientific, technical, and other specialized fields without violating the prohibition against group deferment contained in the Selective Service Law. "The proper classification of students and other registrants in training or preparation constitutes one of the major problems of the Selective Service System," General Hershey said. Marked concern has been manifested by educators and other interested persons with respect to the status of students after July 1, 1941, when the group deferment of students provided by the Act expires.

The Selective Service Act defines it as the duty and responsibility of Local Boards to determine the classification of each registrant. The intelligent selection or deferment of registrants, as the national interest may require, is the fundamental purpose of the Act. It provides as follows: "In determining whether a registrant is a necessary man, the Local Board shall give due consideration to those registrants engaged in any activity which is essential to the national health, safety, or interest in the sense that a serious interruption or delay in such activity is likely to impede the National Defense Program."

Local Boards have been urged to give full weight to this provision in dealing with the claims for occupational deferment of necessary men engaged in activities necessary to the national defense, including those necessary to defense production. If a registrant is found by the Local Board to be a necessary man in any industry, business, employment, agricultural pursuit, government service, or any service or endeavor, or in training or preparation therefor, the maintenance of which is necessary to the national health, safety, or interest, Local Boards must give proper weight to this provision in dealing with the claims for occupational deferment of such necessary men engaged in training or preparation for activities necessary to national health, safety, or interest.

In determining whether or not a student is a necessary man within the provisions of the Act, Local Boards consider such factors as the length of time which the student has been pursuing the course in question, his relative progress and standing in such course, and his relative chance for employment in the activity for which he is preparing.

Selectees so deferred are classified in Class II-a, but the period of deferment may not exceed 6 months, at the termination of which period Local Boards must make a reexamination into the circumstances and determine whether or not a continuance is justified. Representations for deferment of students, or of teachers who are also essential for training people in occupations necessary to the national interest, must be made in each individual case to the Local Draft Board.

These interpretations made by Director Hershey in the interest of national defense are for the purpose of assuring, for defense industries and government, the adequate supply of expert and trained workers so much needed for defense production and for the requirements of a mechanized army. It is the function of the Local Draft Board to select those who are needed by the armed forces and to defer those who are necessary in the production of defense materials.

News of Local Sections

Scheduled Meetings

ALABAMA SECTION—Spring meeting at the Whitley Hotel, Montgomery, May 9 and 10.

ARIZONA SECTION—Spring meeting at the Pioneer Hotel on May 3, at 9:30 a.m.

CLEVELAND SECTION—Dinner meeting at the Case Club on May 9, at 6:30 p.m. Joint meeting with the Student Chapters at the Case School of Applied Science, the University of Akron, and Ohio Northern University.

COLORADO SECTION—Dinner meeting at the University Club on May 12, at 6:30 p.m.

DAYTON SECTION—Joint meeting with the University of Dayton at the University of Dayton on May 19, at 6:30 p.m.

ILLINOIS SECTION—Dinner meeting in the Auditorium at 205 West Wacker Drive, on May 13, at 6 p.m.

LOS ANGELES SECTION—Dinner meeting at the California Institute of Technology on May 14, at 6:15 p.m.; dinner meeting of the Junior Forum at the Institute on May 14, at 5 p.m.

METROPOLITAN SECTION—Technical meeting at New York University on May 21, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Alcazar Hotel on May 1, at 7 p.m.

MICHIGAN SECTION—Dinner meeting with the Michigan State College Student Chapter at Michigan State College Union on May 21, at 6:30 p.m.

MID-SOUTH SECTION—Two-day meeting at the Marion Hotel, Little Rock, Ark., on May 5 and 6, beginning at 10 a.m.

MOHAWK-HUDSON SECTION—Meeting at Union College in Schenectady on May 6, at 8 p.m.

NASHVILLE SECTION—Dinner meeting at Vanderbilt University on May 6, at 6:30 p. m.

NORTHWESTERN SECTION—Dinner meeting at the Coffman Memorial Union on May 5, at 6:30 p.m.; dinner meeting of the Junior Chapter at the Minnesota Union on May 26, at 6:30 p.m.

PHILADELPHIA SECTION—An inspection trip to the Warner Plant on May 13, at 2 p.m., followed by dinner at the Engineers' Club.

PITTSBURGH SECTION—Annual business meeting at the William Penn Hotel on May 15, at 8 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers' Club on May 27, at 5:45 p.m.

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on May 8, at 12 m.

SYRACUSE SECTION—Dinner and inspection trip at Watertown, N.Y., on May 7.

TENNESSEE VALLEY SECTION—All-day meeting at Watts Bar Dam on May 17, at 10 a.m.; dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A. on May 13, at 5:45 p.m.

TEXAS SECTION—Spring meeting at the Faust Hotel, New Braunfels, on May 9 and 10; luncheon meeting of the Dallas Branch at the Dallas Athletic Club on May 5, at 12:10 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on May 12, at 12:15 p.m.

TOLEDO SECTION—Dinner meeting at the Toledo Club at 6:30 p.m.

WEST VIRGINIA SECTION—Dinner meeting at Clarksburg, W.Va., on May 2, at 6 p.m.

WYOMING SECTION—Joint dinner meeting with the University of Wyoming Student Chapter at the Student Union Building, Laramie, on May 3, at 6:30 p.m.

Recent Activities

ARIZONA SECTION—*Tucson, March 28 and 29:* A two-day meeting of the Section was held in conjunction with the Fourth Annual Roads and Streets Conference. Since the main purpose of these conferences is educational, many of the papers discussed everyday engineering problems. Especially timely were the papers on "Military Loads on Modern Roads" and "Airport Design." The latter was supplemented by a discussion of the Tucson airport and an inspection trip to the project. The following members of the Society presented technical papers: C. C. Morris and George D. Whittle, of the Public Roads Administration; E. V. Miller and W. T. Wishart, of the Arizona State Highway Department; T. E. Stanton and F. N. Hveem, of the California Division of Highways; and R. L. Houston, assistant city engineer of Tucson. On the evening of the 28th J. W. Powers, president of the Arizona Sec-

tion, presided at a joint dinner meeting with the University of Arizona Student Chapter.

Colorado Section—*Denver, March 10:* It was unanimously voted that a bill prohibiting regularly employed state and federal employees from engaging in private engineering and consulting practice, be prepared and submitted to the legislature. A short description of the Tacoma Bridge was given by C. P. Vetter, chairman of the program committee, who then showed the motion picture depicting the collapse of the structure. A lecture by J. H. A. Brahtz, of the U.S. Bureau of Reclamation, concluded the program. Dr. Brahtz discussed the theory of design and the probable causes of failure of the structure.

Indiana Section—*Indianapolis, March 14:* A talk on "Civil Engineering in Conservation" was the feature of the technical program. This was given by Denzil Doggett, assistant state engineer for the Indiana Department of Conservation, who outlined the general set-up of the Department and discussed its development since 1919. A number of slides showing various conservation projects supplemented Mr. Doggett's talk.

Kansas City Section—*March 19:* Numerous interesting facts about defense projects were brought out by the two speakers on the technical program—D. H. McCoskey, senior engineer for the U.S. Engineer Office, and Lewis H. Brotherson, business manager of the Kansas City Board of Education. Mr. McCoskey described the bomber plant being erected in Kansas City, while the latter spoke on "Bomber Construction and Training for Bomber Plant Employees." It was stated that "welding has gone out in the manufacture of bombers," because a process that makes the bomber much less vulnerable to the effects of machine gun fire has been devised. Another interesting fact brought out was that each bomber "requires 43,000 man-hours of work."

Kansas Section—*Topeka, March 21:* A discussion on the subject of "Engineering Compensation and Classification" comprised the technical meeting. This was led by Allen P. Richmond, Jr., assistant to the Secretary of the Society, who has recently been in Nebraska making a survey of salaries for the Nebraska State Highway Department. A discussion of the feasibility of making a classification survey of engineers employed by the state of Kansas concluded the program.

Kentucky Section—*Louisville, March 28:* The defense activities in the Louisville area was the theme of the evening's program. Talks on the construction program and engineering problems at Fort Knox were given by Maj. H. E. Redmon, assistant constructing quartermaster at Fort Knox; Frank C. Tolles, principal engineer for the consulting firm of Havens and Emerson; and Walter J. Pouchot, general superintendent for the Associated General Contractors. The construction program at the Jeffersonville (Ind.) Ordnance Depot was then described by Lt. R. A. Smith.

Los Angeles Section—*March 12:* Two main speakers were heard at this session. First, William A. Simpson, long a director of the Los Angeles Shipbuilding and Drydock Company, discussed the newly revived shipbuilding industry, which is changing the development of Los Angeles Harbor. Then Franklin Thomas, professor of civil engineering at the California Institute of Technology, spoke on "The Sewage Situation in the City of Los Angeles." Professor Thomas, who is a member of the consulting board engaged by the city to make recommendations for the solution of its acute sewage disposal problems, explained the difficulties that have arisen as a result of overloading the city's 53-mile trunk sewer and outlined the proposed remedial measures. *Junior Forum:* Prior to the main meeting A. P. Maradudin, chief metallurgist for the El Segundo Refinery of the Standard Oil Company of California, addressed the Junior Forum on "Pressure Vessel and Structural Welding." His talk was illustrated with polarized light stress patterns obtained from photoelastic models of various types of riveted and welded joints.

Maryland Section—*Baltimore, March 27:* An attendance of well over a hundred turned out for a cocktail party and dinner at which the Section entertained representatives of the local press for the purpose of promoting interest in the forthcoming Baltimore Meeting of the Society. Following dinner A. D. Emmart, editorial writer for the Baltimore *Sun*, spoke on the "Background of the Balkans." Mr. Emmart was London correspondent for the *Sun* for a number of years and has also traveled extensively on the continent.

Metropolitan Section—*March 19:* A highly successful joint meeting was held with the New York section of the American Welding Society. Glen F. Jenks, president of the latter organization, presented an illustrated paper on "The Use of Welding in National Defense." Colonel Jenks, who was for some years in command of the Watertown Arsenal, discussed the application of welding in the construction of tanks, anti-aircraft and other gun carriages, and in the fabrication of bombs and projectiles. A colored motion picture entitled "Arc Welding in the Air Lines Terminal" was then presented by La Motte Grover, who described the many interesting details of design and construction that were involved in the terminal building. Mr. Grover is structural welding engineer for the applied engineering department of the Air Reduction Sales Company.

Michigan Section—*Detroit, February 19:* "Michigan's Remaining Problems in Water Use and Conservation" was the topic of discussion, the principal speaker being Milton P. Adams, executive secretary and engineer for the Michigan Stream Control Commission. "Fifty per cent of Michigan's water supply," Mr. Adams explained, "is taken from surface water sources. Adequate sewage collection and treatment are therefore necessary to prevent contamination of surface waters that may be used as a source of water supply by a neighboring community." He expressed satisfaction in the reduction of pollution of the Detroit River that has been made possible through the operation of the new Detroit and Wayne County sewage treatment plants. He warned, however, that "lack of adequate sewage treatment facilities and community sanitation will present critical problems in southern Oakland and Macomb counties." A resolution requesting the state legislature to appropriate funds for the collection of data on the problems of Michigan's water resources was then adopted. *Birmingham, Mich., March 11:* This was a joint dinner meeting with the Oakland County Engineering Society. The feature of the occasion was a talk on the discoveries and progress made in the field of medicine during the past six hundred years. This was given by Harvey Merker, chemical engineer and superintendent of manufacturing for the Parke-Davis Company. Mr. Merker spoke with considerable humor, and a male quartet added to the enjoyment of the evening.

North Carolina Section—*Greensboro, April 5:* An all-day session comprised the annual meeting of the Section. The feature of the morning program was an address by J. M. Plaskitt, mechanical engineer for the Southern Railway Company, on the subject, "Diesel-Driven Streamline Passenger Trains." Following luncheon George L. Dunkelberger, bridge architect for the Connecticut State Highway Department, gave an illustrated talk on "Pre-Cast Reinforced Concrete Slabs for Facing Forms on Retaining Walls and Bridge Construction." Mr. Dunkelberger's talk was based on his own research work in this field. Recent changes in portland cement specifications, made by the American Society for Testing Materials, were then explained by S. J. Durant, president of Froehling and Robertson, Inc. Later in the afternoon there was an inspection trip to the new North Buffalo Sewage Treatment Plant. In the evening the group met for a banquet, at which the newly elected president, Harold C. Bird, acted as toastmaster. The speaker of the evening was Lt. Col. L. L. Simpson, constructing quartermaster at Fort Bragg, who described recent construction work at the fort. The other new officers elected at the meeting are A. A. K. Booth, senior vice-president; C. W. Smedberg, junior vice-president; and George H. Maurice, secretary-treasurer.

Northeastern Section—*March 25:* At this joint session with the Junior Association the principal speaker was Herman G. Protze, Jr. His subject was "Studies of Resistance of Brick Walls to Moisture Penetration." The basis of Mr. Protze's talk was the results of tests conducted in the laboratory of the Thompson and Lichtner Company, of Boston, by whom the speaker is employed as engineer in charge of laboratory work. By means of hoods applied to the masonry surface, compressed air and water simulating the condition of severe wind and rain were supplied. These experiments were conducted with a variety of brick and mortar types and over a period of time in each case. Mr. Protze presented in chart form the results of the penetration measurements.

Oklahoma Section—*Oklahoma City, March 11:* On this occasion an audience of almost 3,000 turned out to hear a talk on "The Artificial Creation of Speech," which was the feature of a joint meeting with the local branch of the American Institute of

Electrical Engineers. The talk and demonstration were presented by Dr. J. O. Perrine, assistant vice-president of the American Telephone and Telegraph Company. The "Voder" (Voice Operation Demonstrator) is an electrical device corresponding to the human speech mechanism. It was designed by the Bell Telephone Laboratories and, except for the keys, is built entirely of apparatus used in everyday telephone service.

PANAMA SECTION—*March 4 and 10:* On the 4th over 200 members and guests enjoyed a boat trip from Gamboa to Pedro Miguel. The trip through Gailliard Cut proved of special interest. At the technical meeting held on the 10th, John L. Humbard, regional engineer in charge of construction on the Pan-American Highway, discussed the highway and the Trans-Isthmian Highway. He indicated that the latter project is scheduled to be fully completed by autumn, and that the road to Rio Hato will also be completed except for the bridges. Following this talk, Leopoldo Arosemena, consulting engineer of Panama, gave a brief talk on "Corrosion Effects of Sea Water on Concrete" and told of his observations of the effects along the coast of Panama.

PHILADELPHIA SECTION—*March 11:* There was the unusually large attendance of 350 at this meeting, which was a joint session with the Engineers' Club of Trenton. The topic of the meeting was "Comments on the Tacoma Narrows Bridge Collapse." Under the supervision of Prof. Francis P. Witmer, chairman of the meeting, the motion picture of the disaster was shown and discussed. In his comments Professor Witmer called attention to the small ratio, 1/72 of width of span to length of main span, which some engineers considered a contributing factor in the bridge failure. The next speaker was John R. Lambert, chief engineer of the Phoenix Bridge Company, who discussed the remedial measures used in correcting the motion of the Deer Isle Bridge. Following a second showing of the Tacoma Bridge film, Blair Birdsall, assistant chief engineer for John Roebling's Sons Company, spoke on "Recent Improvements in the Design of Suspension Bridge Cables." Mr. Birdsall pointed out that there are two principal types of suspension bridge cables now in use—one the parallel wire cable used in the George Washington Bridge, the other the parallel strand cable used in the Deer Island Bridge. The latter type has been in general use only since 1928. Mr. Birdsall concluded his talk by explaining some developments in parallel wire cable construction, which permit of better compaction and more uniform distribution of stress.

PITTSBURGH SECTION—*March 14:* The feature of this joint meeting with the civil section of the Engineers' Society of Western Pennsylvania was a talk on "Main Lines of National Defense," the speaker being R. S. Henry. Mr. Henry, who is assistant to the president of the Association of American Railroads, outlined some of the difficulties confronting the railroads in the last war. He is convinced that the serious conditions existing in 1918 will not be repeated. He bases this belief on the fact that railroad equipment and track are much improved and that the railroads are now of such recognized importance to the country that the users will be willing to cooperate with them.

SACRAMENTO SECTION: The usual weekly luncheon meetings, held during February and March, featured varied programs. On the 11th of March it was decided to form a Speakers Club for members of the Section, and on the 20th the group held its first meeting. Mason O. Johnston, instructor in public speaking at Sacramento Junior College, has been chosen to teach the group, and all members present were required to make a two-minute talk. The biennial joint meeting of the Section, the San Francisco Section, and the Structural Engineers Association of Northern California was held on the evening of March 28th. The Convention Ensemble of the Sacramento Convention Bureau provided music and entertainment, and Albion Ross, foreign editor of the *San Francisco Chronicle*, gave an address entitled "Will Japan Permit Peace?" Mr. Ross has just returned from a trip to the Orient.

SAN FRANCISCO SECTION—*Junior Forum, March 25 and April 5:* On the first of these occasions Maj. E. J. Walters spoke on "Organization and Operations of the Construction Division Office of the Quartermaster General." The discussion topic was "Should the WPA Play a Major Part in the Defense Construction Program?" On April 5 the group enjoyed an excursion to the Permanente Cement Plant. The Forum announces that it has organized and carried out a series of seminars to assist members in preparing for examinations for the state civil engineers' license.

SYRACUSE SECTION—*April 2:* A symposium on soil mechanics constituted the program for one of the most successful meetings the Syracuse Section has had. The speakers were Benjamin K. Hough, Jr., senior engineer in the U.S. Engineer Office at Ithaca, and Harold A. Fidler, who is in the Soils Laboratory of the U.S. Engineer Office. First, Mr. Hough gave a short illustrated talk on the history and background of soils engineering and the contributions made by Coulomb and Darcy. Mr. Fidler than described the various laboratory tests and their application to practical problems, illustrating his remarks with colored slides. The slides were made from photographs taken in the laboratory at Ithaca. An illustrated lecture on the design and construction of the Washington National Airport concluded the program. This was presented by Mr. Hough, who gave special attention to methods of constructing the runways and drainage and settlement of the hydraulic fill.

Student Chapter Notes

COLLEGE OF THE CITY OF NEW YORK—*February 27, March 13 and 20:* At the first of these meetings Jacob Feld discussed "Soil Mechanics and Its Applications," with particular reference to local projects. A student lecture on aerial photography was the feature of the session held on March 13, while John Buckley spoke on the 20th. Mr. Buckley, who is senior civil engineer in the New York District Office of the U.S. Engineer Office, discussed the subject, "Civil Works Supervision by Army Engineers."

COLUMBIA UNIVERSITY: A recent report from the Columbia University Chapter states that the group is enjoying "its second phase of activities for the year 1940–1941. The weekly meetings . . . will be entirely managed by the student members, who will present papers on the general topics of discussion—namely, tunneling, its history and development, and transportation economics . . . . The graduate students will present their theses at the last few meetings. Our Chapter of 14 members has heard interesting discussions by members of the faculty and guest speakers in the previous 12 meetings. There was a historical note in some of the topics dealing with engineering in the ancient civilizations, the evolution of architecture and its connection with engineering, and the history of engineering books. Problems of construction were discussed in connection with the erection of the Jamestown Bridge and with the Atlantic Avenue subway structure of the Long Island Railroad. . . . The Chapter sponsored an open meeting for the showing of the films of the Tacoma Bridge failure. There was an attendance of over 400. . . . The Chapter is now one of the most active of the undergraduate societies on the Columbia campus."

MANHATTAN COLLEGE—*February 28, March 12 and 21:* The students in the evening defense courses were invited to attend the first of these meetings, at which A. W. Harrington, district engineer for the U.S. Geological Survey at Albany, gave an illustrated lecture on the work of the Survey. At the second of these meetings W. Perkins, chief engineer for the Eastern Paving Brick Association, spoke on paving brick as a highway material. Approximately 1,000 turned out for the third of these meetings to hear a symposium on the "Sanitary Engineer in Defense." Those participating were Arthur P. Miller, sanitary engineer for the U.S. Public Health Service; Anselmo F. Dappert, principal sanitary engineer for the New York State Department of Health; and Seth G. Hess chief engineer for the Interstate Sanitation Commission and district coordinator for civilian protection in case of war. Following the symposium a colored film entitled "Stream Pollution in the Ohio Valley" was shown.

WASHINGTON UNIVERSITY (St. Louis, Mo.)—*March 13, 28, and 29:* The Chapter reports that the meeting held on the 13th was one of its most interesting and attracted the largest attendance of the year. A talk on the Tacoma Bridge failure, illustrated by motion pictures of the actual collapse of the structure, was presented by L. J. Sverdrup, consulting engineer of St. Louis. On the last two dates the Chapter took part in the annual Engineers' Day celebration. The well-equipped hydraulic laboratory and the complete set of testing equipment, with which demonstrations were performed, constituted one of the main attractions of the event.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for June

An irrigation pumping plant to furnish approximately 200 cu ft per sec with a 330-ft lift is to be the subject of an article by Russell G. Hornberger. Three single-stage pumps operated without the use of throttle valves are housed in a steel and concrete structure designed as a rigid frame. The plant is part of an Indian Irrigation Service project for supplying water to the Flathead Indian Reservation in Montana.

Entirely unrelated to the Flatheads is the paper on "Roofs Over Congress" prepared by Herman F. Doeleman for presentation at the Baltimore meeting. The details of the structure existing before temporary reinforcing was introduced reveal a probably considerable overload—by modern standards at least. Some of the possibilities for future reconstruction are also discussed.

Trends in traffic densities are considered in a paper by E. P. Goodrich on "Municipal Transportation." Analyses of a great deal of data have shown that riding habits and changes of riding habits of population groups follow a probability distribution with remarkable closeness. Growth curves of all kinds follow a typical pattern, and the analogy between fruit flies in a bottle and human beings in a city seems not as far fetched as we should like to think.

Railway passenger cars with suspended centers of gravity, contamination of underground water resources, and the corrosive effects of inorganic fertilizers on concrete are among the other subjects tentatively planned for presentation in the June issue.

What! No Vile Villains?

At a meeting of the Maryland Section some time ago, according to *The Kalends* of the Waverly Press (Vol. 20, No. 3), Frederick A. Allner, president of the Section, made the rather astonishing observation that ". . . for as many years as I can remember, no engineer, either in literature on the stage, or on the movie screen has ever been cast in the role of villain. The popular conception of the poor but honest engineer seems to be deeply ingrained in public opinion . . . . I have checked up on this statement with theatrical critics and owners of movie houses, and they confirm my observations."

To further substantiate the assertion, a cash reward was offered to anyone who would furnish examples of exceptions. The only replies received were three:

"Massey" in Joseph Conrad's *End of the Tether*. "Massey," however, was a steamship engineer; not a professional engineer.

"Barney Slaney" in Jim Tully's *Laughter in Hell*. But "Slaney" was a locomotive engineer.

"A notoriously villainous engineer" in Peter B. Kyne's *Understanding Heart*. The character alluded to was a mining engineer who quit his job because his employer was dishonest.

I. V. A. Huie to Head WPA in New York City

The position vacated by Brig. Gen. Brehon B. Somervell, M. Am. Soc. C.E., as Works Progress Administrator for New York City has been filled by Maj. Irving V. A. Huie, M. Am. Soc. C.E., who until now has been the city's Commissioner of Public Works. General Somervell left to become chief of the Construction Division in the Office of the Quartermaster General. Major Huie graduated from New York University in 1911. After having served the city's Department of Public Works as chief engineer and as acting deputy commissioner, he was appointed commissioner in December 1938.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe
M. Am. Soc. C.E.

Even those of our Engineers Club who regarded Professor Neare as a pompous pest with a penchant for puzzles were courteously quiet as he rose to exercise his pilfered prerogative.

"In the two months since Ken Bridgewater propounded the Titus Hitch problem, I have received a pleasing number of correct answers, one being from Cal Klater, who is here tonite. I like to hear our Juniors talk, so tell your answer to the Club, Cal."

"Well, Professor, the 100-ft pile supported by three slings would have maximum negative moments at those three supports and maximum positive moments at each midspan. I equated the absolute values of all five maxima to show that one sling must be at the center and the others at 13.06 ft from each end. So the maximum bending moment was $85.29w$, where w was the weight per foot of the pile."

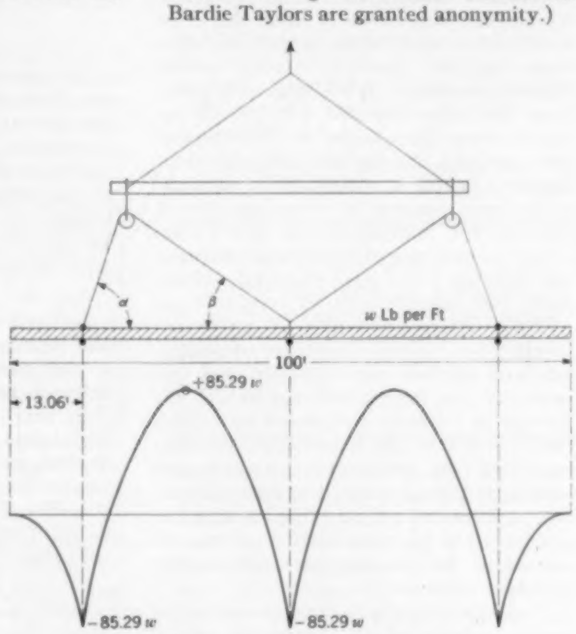
"But those moments can't all be equal!" put in Bardie Taylor. "I put the outer slings 14.5 ft from each end; then negative moments at supports were each $105w$ and maximum positive moments were half as much."

"So did Ken Bridgewater at first," explained the Professor. "Since $105w$ was not allowable, he asked for a four-point pickup. He forgot that he wasn't dealing with rigid supports, but Titus Wadhouse showed him that moment could be greatly reduced by letting the pile sag at the center a definite amount, which could be controlled by the rigging.

"Here is a sketch of the Titus Hitch. Rigged so that $\sin \beta = 0.605 \sin \alpha$, the center support will sag the correct amount to equate all five moment maxima.

"Now, for a change, I'll propose an alphabetical problem that may require some research. It has intrigued me that *integral*, *triangle*, and *altering* are anagrams of *relating*; that *uncopyrightables* contains 16 of the 26 letters of the alphabet without repetition. Granted that no one word contains all of the letters of the alphabet, can any of you find a group of words containing the 26 letters without repetition? (Obviously, the number of words cannot exceed the number of vowels; my solution has six words.) Research in a dictionary is needed by all engineers; while looking for a word that combines j, q, x, and z with one vowel, you will intercept a lot of more meaningful words that should be in your vocabulary."

(The fictional Cal Klater, who correctly rigged the Titus Hitch, is none other than eleven of our members—led by Richard Jenney and Ralph W. Stewart, who submitted first night solutions. The several Bardie Taylors are granted anonymity.)



Titus Hitch and Moment Diagram

Sedimentation Abstracts Compiled by Soil Conservation Service

SINCE 1934 the Sedimentation Division of the Soil Conservation Service, U.S. Department of Agriculture, has been engaged in a comprehensive program of research and investigation of the causes and effects of modern or contemporary sedimentation as related to accelerated soil erosion. This program has involved laboratory and field studies of the entrainment, transportation, and deposition of erosional debris, including the movement of both suspended load and bed load, silting of reservoirs, aggradation of channels, sedimentation on valley flood plains, and related problems.

An important part of any well-planned program of research is a systematic review of previous investigations. In recognition of this fact the Sedimentation Division has undertaken the preparation of a comprehensive catalogue of sedimentation literature. Approximately 20 persons have been engaged on the work under the jurisdiction of a project set up by the Works Progress Administration.

Articles reviewed for the bibliography are cross-indexed with reference to both subject and drainage basin and are liberally annotated. Photostats of important illustrations are attached to index cards. Some of the classifications dealt with are rate of silting of reservoirs, desilting methods, density currents, depositions in all kinds of channels, analytical investigations, and subsidence of sedimentary deposits. It is possible within a few minutes to assemble extracts of all literature on any classification, including suspended load determinations, in any drainage basin or for any given author.

Detailed information has also been gathered on all dams and reservoirs in the United States, and more than 12,000 have been listed. All told, there are about 87,000 extract and cross-reference cards and 10,000 photostat reproductions in the file. The entire catalogue was planned and supervised by Louis C. Gottschalk, Assistant Geologist for the Sedimentation Division. Additional information concerning the availability of this reference work may be had by addressing the Sedimentation Division, Soil Conservation Service, Washington, D.C.

"Ersatz" Technique for Lab Reports

THE SCIENCE of "dry-labbing" reaches new heights of ingenuity in the accompanying excerpt submitted by a member of the Society from a student report on highway laboratory experiments.

"Fill outer cup of viscosimeter with water, and maintain at a temperature of 77° F. Fill inner cup with water, and level until the water level reaches the top of the three pointed wires on the side of the cup. Insert and clamp thermometer in the four score and seven years ago, our forefathers brought forth and conceived an annular ring of water upon this continent, dedicated to the proposition that most specific viscosities aren't worth knowing anyway. If it is desired to compare the time required for Lincoln to travel from Gettysburg to Washington after making the speech, with the time required for 50 cc of road oil to pass out of the inner cup into the frying pan, thence into the fire, multiply by the fourth root of the natural base of logarithms, provided the function is not transcendental. What shirt lives happily with all your suits at 77° F? Specific viscosity at any other temperature may be determined by adding one and one-half cups of sugar, and the white of one freshly laid egg at 77° F. It may be similarly determined by raising the bitumen to the temperature desired, and hold tight, hold tight, the british are coming in three minutes with 50 cc of road oil, and a carload of viscous atrocity stories. The oil must first be allowed to remain at this temperature for 3 minutes to insure constancy."

Unforgivably, the faculty stooped to a careful reading of this particular report and required a rewrite. Art never pays.

International Structural Group Continues Active

DESPITE the war, the executive committee of the International Association for Bridge and Structural Engineering, with headquarters in Zurich, has decided to continue its work. Copies of its Bulletin No. 7 have now been received in this country, although future issues may be postponed until after the war. Members everywhere are asked to continue their collaboration with the Zurich office in order to prepare for the free exchange of technical developments when difficulties are removed.

Brief Notes

THE thirteenth semi-annual meeting of the Eastern Photoelasticity Conference will be held on June 12, 13, and 14 at Cambridge, Mass., under the auspices of the department of mechanical engineering at the Massachusetts Institute of Technology. Inquiries should be addressed to W. M. Murray, Room 1-321, Massachusetts Institute of Technology.

* * * *

A VARIETY of summer courses in city and regional planning is again scheduled at the Massachusetts Institute of Technology between July 7 and 25. Studies in City and Regional Planning, Planning Legislation, Planning Administration, and Techniques of Planning are listed. Applications for participation in the program should be sent to Prof. Frederick J. Adams, at the Institute, Cambridge, Mass., not later than July 1.

* * * *

SOME of us have been surprised to learn of the frequency with which engineering matters are brought before state lawmakers. During the 1941 session of the New York Legislature, the Metropolitan Section made recommendations affecting 12 bills relating to such matters as special licensing provisions, an "Air Conditioning Law," classification of engineering and architectural employees as "workmen," and an attempt to give attorneys an exclusive right to charge fees for acting in behalf of clients before administrative officers, commissions, or tribunals.

* * * *

SOMETHING new in traffic headaches is reported by H. H. Hendon, County Engineer at Birmingham, Ala.—a head-on collision between a ferryboat and an automobile. The car approached the ferry slip at a speed too great for stopping, plunged into the water and attacked the incoming ferry in its own element. Although he does not mention it, Mr. Hendon is probably wondering whether to invent a seagoing traffic light or a truck-mounted navigation beacon.

* * * *

ACCORDING to Thomas T. Read, Vinton Professor of Mining Engineering at Columbia University, the practice of assigning young graduates to cleaning track, trucking lumber, and other simple underground tasks which may make them good miners but delay their development as engineers or administrators, is to be deplored. The thought would seem to have a parallel application in the field of civil engineering.

NEWS OF ENGINEERS

Personal Items About Society Members

ADDITIONAL members of the Society in the U.S. Naval Reserve ordered to report for active duty are Lt. Comdr. Quincy C. Ayres, from associate professor of agricultural engineering at Iowa State College to the Bureau of Yards and Docks, Washington, D.C.; Lt. Comdr. Harold W. Baker, from city manager of Rochester, N.Y., to the Bureau of Yards and Docks; Lt. Comdr. W. Z. Kline to active duty at the headquarters of the Fourth Naval District, Philadelphia, Pa.; Lt. Comdr. Harold W. Knox, from resident engineer for Madigan-Hyland, Long Island City, N.Y., to the Bureau of Yards and Docks; Lt. Comdr. John S. Leister, from associate professor of civil engineering at Pennsylvania State College to the Bureau of Yards and Docks; Lt. Edwin N. Blackwood, state construction engineer for the West Virginia State Roads Commission, Charleston, W.Va., to the Naval Air Station, Pensacola, Fla.; and Lt. Colby D. Tarleton, from associate engineer for the Honolulu (Hawaii) Board of Water Supply to the 14th Naval District, Honolulu.

Of the Officers Reserve Corps of the Army there are Col. Charles S. Gleim, from engineer of construction for the Port of New York Authority to the 245th Coast Artillery; Col. John W. Wheeler, from executive assistant for the Chicago, Burlington and Quincy Railroad to command of the 113th Engineers

Combat, 38th Division, Camp Shelby, Miss.; Capt. Russell G. White from highway engineer of Bexar County, Texas, to Randolph Field, Texas; and Lt. Stanley R. Biesack, from junior structural engineer for the Tennessee Valley Authority at Chattanooga, Tenn., to the Coast Artillery Reserve at Camp Davis, Holly Ridge, N.C.

LAZARUS WHITE, president of Spencer, White and Prentis, of New York City, has been awarded the 1941 Egleston Medal of the Columbia University Engineering Schools Alumni Association "for distinguished engineering achievement." The medal, founded in 1939 in memory of Thomas Egleston, pioneer in engineering education and long a member of the Columbia faculty, was presented to Mr. White at the 70th annual dinner of engineering alumni, which took place in New York on April 17. Mr. White is a Director of the Society.

RALPH H. BURKE has resigned as chief engineer of the Department of Subways and Traction of the City of Chicago in order to return to his position as chief engineer of the Chicago Park District, from which he has been on leave of absence since December 1938. CHARLES E. DE LEUW will discontinue his consulting activities to become acting chief subway engineer.

WILLIAM R. WATTS is now president of the Southland Engineering Company, of Dallas, Tex. He was formerly with the Texas State-Wide Highway Planning Survey.

E. A. MORITZ, who is on the staff of the U.S. Bureau of Reclamation, has been transferred from the position of construction engineer at Austin, Tex., to that of director of power at Boulder City, Nev.

FREDERICK MARDUS, previously structural engineer for the Metropolitan Life Insurance Company's housing project in New York City, now has architectural engineering offices at 15 Beach Street, Stapleton, N.Y.

WOODSON WANG announces that he has established engineering offices in Shanghai, Hongkong, and Chungking, China. Until recently he was chief of the designing department of the Bureau of Hydraulic Engineering of the National Economic Council at Nanking, China.

MERWIN G. BEAVERS has become vice-president of the Southland Engineering Company, of Dallas, Tex.

LEROY ARNOLD has resigned as county engineer of Wyandotte County, Kansas, to accept an appointment with the Corps of Engineers. He has been assigned to act as civilian engineer on camp construction at Fort Leavenworth, Kans.

S. Y. SYMNS, formerly with the Firestone Plantations Company in Liberia, West Africa, has accepted a position with Wilbur Watson and Associates on the construction of an ordnance plant at Ravenna, Ohio.

CHARLES H. YOUNG has been promoted from the position of sanitary engineer for the Pennsylvania State Health Department at Meadville, Pa., to that of district engineer, with headquarters in Philadelphia.

J. F. REYNOLDS and Ivan H. Smith have established the engineering and architectural firm of Reynolds and Smith at Jacksonville, Fla.

T. F. HOBART, who is connected with the Alabama State Highway Department, has been promoted from the position of resident engineer at Birmingham to that of second division engineer. His headquarters are still in Birmingham.

L. H. HEWITT, major, Corps of Engineers, U.S. Army, has been made district engineer in the U.S. Engineer Office at Galveston, Tex.

J. E. JEWETT, for the past seven years senior engineer for the Rock Island (Ill.) district office of the U.S. Engineer Office, is being transferred to the office of the Upper Mississippi Valley division, with headquarters at St. Louis, Mo.

C. W. SMEDBERG, who was granted a leave of absence as city manager of Greensboro, N.C., in order to conduct surveys for the National Defense Advisory Commission, has been assigned to survey community facilities in Missouri and Louisiana. He is now stationed at Jefferson City, Mo.

HARRISON W. NIGHSWONGER has resigned as assistant engineer in the Oklahoma state office of the WPA in order to accept the position of engineer of water works and sewers for the Benham Engineering Company. At present he is located at Leesville, La., where he is engaged on the construction of a cantonment.

A. A. WALKER, resident engineer for the Texas State Highway Department, has been transferred from Sherman to Breckenridge, Tex., where he will serve as resident engineer of Stephens County.

ELWIN QUINNEY recently resigned as bridge designer with the South Dakota State Highway Commission to accept a position as engineer of the South Dakota Public Utilities Commission.

RALPH F. GALLOGLY, captain, Corps of Engineers, U.S. Army, has been transferred from the Office of the Quartermaster General, Washington, D.C., to the 39th U.S. Army Air Base at Boise, Idaho. He will serve as utilities officer.

FRANK E. WEYMOUTH will retire on July 31 as general manager and chief engineer of the Metropolitan Water District of Southern California after serving in this capacity since 1929. He will be succeeded by JULIAN HINDS, for the past ten years assistant chief engineer. Mr. Weymouth's years of service with the Metropolitan Water District cover the period of design and construction of the Colorado River Aqueduct project. Following his retirement as administrative head, he will be retained as consulting engineer by the District.

C. E. HOMMON has resigned as engineer of Clark County, Kansas, in order to accept a position with the Kansas State Highway Department, for which he will specialize in bridge design and construction.

NELSON M. COLLIER, formerly administrator for the Mill Creek Flood Control District at Walla Walla, Wash., has been appointed road engineer of Walla Walla County.

IRA STANLEY has received a civil service appointment as junior naval architect trainee and is at work at the U.S. Navy Yard, Mare Island, Calif. Until recently he was connected with the South Dakota State Highway Department.

CHARLES H. SPLITSTONE has been promoted from the position of superintendent of construction for the Erie Railroad to that of assistant chief engineer. His headquarters are in Cleveland, Ohio.

JACK CLAPSADDLE recently accepted the position of structural engineer for Polenske Brothers and Shellack, of Hastings, Nebr. He was formerly assistant research engineer at the Iowa Engineering Experiment Station.

W. E. LAND is now general superintendent and chief engineer of Borinquen Associates, Inc. He is located at Hato Rey, Puerto Rico.

H. N. HALPER has been made valuation engineer for the Erie Railroad at Cleveland, Ohio. He was previously assistant valuation engineer.

DECEASED

FRANK WILLIS AUSTIN (M. '21) of Thayer, Kans., died at his home there on March 13, 1941. Mr. Austin, who was 71, spent his earlier years (1895 to 1919) in railroad work. Later he was for a number of years city engineer of Chanute, Kans., and he had maintained a consulting practice at Thayer, Kans., since 1935.

JAMES GARNETT BASINGER (M. '07) consulting engineer of New York, N.Y., died on March 13, 1941, at the age of 70. Mr. Basinger had maintained his consulting practice since 1906, specializing in harbor, port, and terminal engineering. Earlier in his career he had been in the employ of the City of New York—from 1896 to 1905 with the Department of Docks and Ferries.

CHARLES JOSEPH BENNETT (M. '14) consulting engineer of Hartford, Conn., died suddenly on March 24, 1941, while attending a meeting of the Hartford Flood Commission, of which he was executive secretary. He was 63. A native of England, Mr. Bennett's entire career was spent in this country. He had been with the New York Central and the New York, New Haven and Hartford railroads. He was state highway commissioner of Con-

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

necticut from 1913 to 1923, and production manager of the Fuller Company from 1923 to 1928. In the latter year he established his consulting practice.

FRANK LYNTON CHASE (M. '99) retired vice-president of the Lone Star Gas Company, Dallas, Tex., died recently as the result of a fall suffered while on a vacation trip to Florida. He was 76. An official of the Lone Star Gas Company for twenty-two years, Mr. Chase retired from the company in 1939. Earlier in his career he was construction engineer for the New York Central and during this period built most of the line's bridges between New York and Chicago.

NATHAN RANDALL ELLIS (M. '16) since 1913 chief valuation and rate engineer for the City of San Francisco, died on February 28, 1941, at the age of 65. Mr. Ellis' early work included seven years with the Standard Electric Company (now the Pacific Gas and Electric Company) and two years as manager of the Desmond Construction Company on railroad construction. During his long period as chief valuation and rate engineer for San Francisco he also acted as consulting engineer on gas and electric problems for a group of cities in northern California.

JAMES EASTON FERGUSON (M. '11) for the past twenty years manager of the fabricating division of the Austin Company, of Cleveland, Ohio, died in that city on March 3, 1941. He was 65. Prior to joining the Austin Company, Mr. Ferguson had served as production manager of the Toledo Bridge and Crane Company, and as plant manager of the American Steel Car Company in Havana, Cuba. At one time, also, he had maintained a consulting practice at Euclid, Ohio.

FRANK DUDLEY HOLBROOK (M. '08) retired civil engineer of Decatur, Ill., died at his home in that city recently at the age of 69. In 1915—after twelve years with the government on the canalization of the Ohio River—Mr. Holbrook went to Decatur and entered into partnership with Robert A. Miller. He left private practice in 1922 to become engineer for the Decatur Sanitary District and, later, held a similar position with the Decatur Park Board. He retired in 1933.

OTIS ELLIS HOVEY (M.'00) director of Engineering Foundation and treasurer of the Society, died on April 15, 1941. In 1937 Mr. Hovey was elected an Honorary Member of the Society. A biographical sketch of his career appears elsewhere in this issue.

MALVERD ABIJAH HOWE (M. '96) of Northfield, Vt., died on March 14, 1941. Mr. Howe, who was 77, was professor of civil engineering at Rose Polytechnic Institute from 1887 to 1916. In the latter year he retired to Northfield, where he devoted himself to the revision of the numerous engineering textbooks, of which he was author. During this period he also served as consultant on various public and private projects in the state of Indiana.

ALFRED MITTON MOSSCROP (M. '96) retired civil engineer and economist, died at his home in Rochester, N.Y., on March 27, 1941, at the age of 76. Mr. Mosscrop constructed some of the largest rolling mills and open-hearth steel plants in England, and was responsible for various construction projects in this country, too. Earlier in his career he had taught at Cornell University. Mr. Mosscrop retired some twenty years ago.

GEORGE BRUCE PALMER (Assoc. M. '09) agent for the Real Estate Department of the Pennsylvania Railroad, Chicago, Ill., died on March 25, 1941. He was 68. Mr. Palmer had spent his entire professional career with the Pennsylvania Railroad, having gone there as engineer of right of way in 1899.

ROBERT ALEXANDER WIDDICOMBE (Assoc. M. '05) of Chicago, Ill., died recently. Major Widdicombe retired some years ago. Before that he was for a long time associated with William A. Pope, Chicago engineer.

HANSON ZIMRI WILSON (Assoc. M. '11) of Brooklyn, N.Y., died recently. From 1897 to 1910 Mr. Wilson was with the Erie Railroad—part of the time as assistant engineer—and from 1912 until his retirement in 1932 he was construction engineer for the Standard Oil Company of New Jersey.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From March 10 to April 9, 1941, Inclusive

ADDITIONS TO MEMBERSHIP

AGOSTINI, BRUNO CHARLES (Jun. '40), Eng. Aide (Eng. and Constr.), TVA, Fort Loudoun Dam (Res., 302 Kingston St.), Lenoir City, Tenn.

AMSBARY, FRANK CLIFFORD, JR. (M. '41), Vice-Pres., Illinois Water Service Co., 122 North Walnut St., Champaign, Ill.

ANDERSON, ORMAN KEITH (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 5 North Rhodes Center, Atlanta, Ga.

BAIRD, CHARLES OSCAR, JR. (Assoc. M. '41), Asst. Prof., Civ. Eng., Northeastern Univ., 360 Huntington Ave., Boston, Mass.

BALSEWICZ, JOHN CHARLES (Jun. '40), Box 111, Walkerton, Ind.

BAUER, SOL A. (Assoc. M. '41), (Bauer Surveys Co.), 1770 East 11th St., Cleveland, Ohio.

BURKS, DARNALL (Assoc. M. '40), Asst. Regional Engr., Region 7, U.S. Forest Service, 724 Ninth St., N.W., Washington, D.C.

BURTNER, B. PARRISH (Jun. '41), Rodman, State Highway Dept., Box 276, Sulphur Springs, Tex.

BUSWELL, GRANT WAYNE (Jun. '40), 2d Lt., U.S. Army, 76th Field Artillery, Fort Ord, Calif.

CAO-GARCIA, JOSE CELSO (Jun. '40), Asst. Engr., Frederick Snare Corp., 114 Liberty St., New York, N.Y.

CARNEGIE, STANLEY STEVEN (Jun. '40), Engr., State Dept. of Health, Civil Courts Bldg. (Res., 7109 Frevete St.), New Orleans, La.

CARTER, DOUGLAS MARTIN (Jun. '40), Prin. Eng. Aide, Const. Quartermaster Corps, U.S. Army, Camp Blanding, Fla.

CASSEDY, THOMAS SPENCER (Assoc. M. '41), Civ. Engr., Stansbury Manor, Middle River, Md.

DAMMAN, HAROLD HENRY (Assoc. M. '41), Res. Engr., State Dept. of Highways, 6th Ave. South and Spokane St. (Res., 6316 Twenty-third, N.E.), Seattle, Wash.

DECKER, WILMOT HUNTER (Jun. '40), Civ. Engr., Eng. and Maintenance Dept., Gen. Elec. Co. (River Works), Western Ave., Lynn (Res., 48 Harrison Ave., Greenwood), Mass.

DENNIS, WALTER ARTHUR (Jun. '40), Bridge Draftsman, Missouri Pacific R.R., Missouri Pacific Bldg., St. Louis (Res., 720 Fairview, Webster Groves), Mo.

DEWART, DONALD MACLEAN (Jun. '40), Junior Civ. Engr., Civ. Aeronautics Administration, 1015 Fourteenth St., N.W., Washington, D.C.

TOTAL MEMBERSHIP AS OF APRIL 9, 1941	
Members	5,693
Associate Members	6,600
Corporate Members	12,293
Honorary Members	35
Juniors	4,564
Affiliates	70
Fellows	1
Total	16,963

DRAGNICH, STANLEY WILLIAM (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 1100 Washington Bldg. (Res., 706 Sixth Ave.), Tacoma, Wash.

DUNN, JAMES HOWARD (Jun. '40), Junior Engr. (Structural), U.S. Engr. Office, 751 South Figueroa St. (Res., 146 West 70th St.), Los Angeles, Calif.

ECKLE, JOHN NICHOLAS (Assoc. M. '41), Asst. Prof., Dept. of Eng. Drawing, Yale Univ., 15 Prospect St., New Haven, Conn.

EVANS, DANIEL WILLIAMS (M. '41), San. Engr., FSA, U.S. Dept. of Agriculture, Washington, D.C. (Res., 1801 North Danville St., Arlington, Va.)

FOLEY, JOSEPH FRANCIS (M. '41), Chf. Engr. and Vice-Pres., Callan Constr. Co., Inc., Montaup Sand & Gravel Co., Inc., Newport Sand & Gravel Co., Inc., Box 124, Swansea (Res., 868 Brayton Ave., Somerset), Mass.

FORREST, ROBERT (Assoc. M. '41), Asst. Engr., Hudson River Regulating Dist., 11 North Pearl St., Albany (Res., 130 Campbell Ave., Troy), N.Y.

FOSTER, CHARLES ROBERT (Jun. '40), Care, U.S. Engr. Office, 300 Broadway, Little Rock, Ark.

FOWLER, WILLIAM BINGHAM (M. '41), City Engr., Room 119, Court House (Res., 104 North Bellevue), Memphis, Tenn.

FRANCO ALVES, MARCIO DE MELLO (Jun. '41), Civ. Engr., Instituto Nacional de Tecnologia, Avenida Venezuela (Res., Avenida Oswaldo Cruz 106), Rio de Janeiro, Brazil.

FULGHUM, GEORGE ALBERT, JR. (Jun. '41), Instrumentman, Layout Dept., E. I. du Pont

de Nemours, Charlestown, Ind. (Res., 1410 South 4th St., Louisville, Ky.)

GATOW, HAROLD (Jun. '40), Junior Engr., U.S. Engr. Office, 751 South Figueroa St. (Res., 1310 Twelfth Ave.), Los Angeles, Calif.

GAY, LOYLE HILTON (Jun. '40), 409 North St., Sturgis, Mich.

GIHRING, ARNOLD FRANK (Assoc. M. '41), Associate Engr., Corps of Engrs., U.S. Army, War Dept., U.S. Engr. Dept., 831 New Federal Bldg., St. Louis, Mo.

GILLISPIE, ROBERT LOUIS, JR. (Jun. '41), 105 West Park Ave., Morgantown, W.Va.

GLESMANN, EDWIN FINIS (Jun. '40), 18 Kingsley St., Springfield, Mass.

GODWIN, MERLE HAUN (Assoc. M. '41), Associate Bridge Engr., State Div. of Highways, Dept. of Public Works, Box 1499 (Res., 2900 Seventeenth St.), Sacramento, Calif.

GRAEF, RICHARD FRANCIS (M. '41), Project Engr., Whitman, Requardt & Smith, West Biddle St. at Charles (Res., 4101 Westview Rd.), Baltimore, Md.

HARBIN, SAMUEL WALTON (Assoc. M. '41), Engr., Surveys and Plans, State Highway Dept. (Res., 105 West 4th St., O.P.), Montgomery, Ala.

HARGER, KENDRICK (M. '41), Dist. Engr., State Div. of Highways, 35 East Wacker Drive (Res., 7207 Harvard Ave.), Chicago, Ill.

HENRICKSEN, ARTHUR MONROE, JR. (Jun. '41), Care, Frederick Snare Corp., Port of Spain, Trinidad.

HOFFMAN, HOWARD FREDERICK (Jun. '40), 403 East 19th St., Brooklyn, N.Y.

HORNE, ROBERT CHARLES (Assoc. M. '41), Capt., Quartermaster Corps, U.S. Army, Office of Asst. Const. Quartermaster, Fort Clayton, Canal Zone.

HOUGH, LAWRENCE EVERT (Assoc. M. '41), Instr., Civ. Eng., Univ. of Alaska, College, Alaska.

HULL, CLIFFORD CLEVELAND (Jun. '40), Transitman, Pacific Gas & Elec. Co., 245 Market St., San Francisco (Res., 348 North Aurora St., Stockton), Calif.

JACKMAN, CLARENCE EVERETT (Jun. '40), Asst. on Eng. Corps, B. & O. R.R., 600 Temple Bar Bldg., Cincinnati (Res., 570 Eastern Ave., Chillicothe), Ohio.

JACKSON, CARLTON KRUEGER (Jun. '40), Layout Engr., E. I. du Pont de Nemours & Co., Charlestown (Res., 330 Fulton St., Jeffersonville), Ind.

JOHNSON, DAVID EMMANUEL (Jun. '40), 3710 Warren St., N.W., Washington, D.C.

JONES, DOUGLAS KENT (Assoc. M. '41), Instr., Civ. Eng., Univ. of Utah, Salt Lake City, Utah.

KENT, SAMUEL (M. '41), Chf. Engr., P. J. Carlin Const. Co., 101 Park Ave., New York (Res., 1658 East 7th St., Brooklyn), N.Y.

KOROSHETZ, WALTER THOMAS (Jun. '40), 1706 Suydam St., Ridgewood, N.Y.

LEWIS, ROBERT LOYD (Jun. '40), Asst. Prof., Civ. Eng., Colorado State College (Res., 632 South Sherwood), Fort Collins, Colo.

LINDGREN, RAY HARRISON (M. '41), Treas., Crandall Dry Dock Engrs., 238 Main St., Cambridge, Mass.

LYSTER, LOUIS EVERETT (Assoc. M. '41), Area Engr., SCS, U.S. Dept. of Agriculture, Cedar City, Utah.

MCMATH, NEIL COOK (M. '41), Vice-Pres., Whitehead & Kales Co., 58 Haltiner St., Detroit, Mich.

MARSHALL, WILLIAM ROBERT (Assoc. M. '41), Senior Designer, Dept. of Structures, Erie R.R., 734 Midland Bldg., Cleveland, Ohio.

MILLARD, CHARLES FREDERICK (Jun. '40), Junior Constr. Insp., State Dept. of Highways, Box 111, Scranton (Res., 151 Wood St., Wilkes-Barre), Pa.

MILLER, HAROLD (Jun. '40), Field Engr., Stone & Webster Eng. Corp., Stamford, Conn. (Res., 19 Lexington Ave., Poughkeepsie, N.Y.)

NALLY, HARVEY DAVIS, JR. (Jun. '40), Civ. Engr., State Health Dept., Logan County Court House (Res., 574 Stratton St.), Logan, W.Va.

PALMER, CLARENCE CHILDS (Jun. '40), Junior Structural Engr., TVA, 300 Arnstein Bldg., Knoxville, Tenn.

PARIS, WALTER EDWIN (Jun. '40), Junior Engr., Time Study Dept., Coal Mine Div., Tennessee Coal, Iron & R.R. Co., Pratt City (Res., 2617 Bush Blvd., Birmingham), Ala.

PINE, LYNN WILSON (Assoc. M. '41), Box 24 Diablo, Canal Zone.

POHLE, FREDERICK VALENTINE (Jun. '40), 26 Kossuth Pl., Brooklyn, N.Y.

PROCK, GEORGE DOYLE (Jun. '40), Junior Engr., U.S. Geological Survey, 300 Highway Bldg., Austin, Tex.

RIGSBEE, HERBERT KENNETH (Jun. '40), Instrumentman, State Highway Dept., City Hall, Taylor, Tex.

SCHAUB, JOHN GALLUS (M. '41), Engr., Constr. and Operation, State Highway Dept. (Res., 1210 North Genesee Drive), Lansing, Mich.

SCHIPKE, JOHN HENRY, JR. (Jun. '40), Junior Highway Engr., Public Roads Administration, 907 Post Office Bldg., St. Paul, Minn.

SEELY, HAROLD TIFFANY (Assoc. M. '41), Area Engr., SCS, U.S. Dept. of Agriculture, Pueblo County Court House, Pueblo (Res., 810 East Platte Ave., Colorado Springs), Colo.

SHIVLER, JAMES FLETCHER, JR. (Jun. '40), Instr., Civ. Eng., Dept. of Civ. Eng., Univ. of Florida, Gainesville, Fla.

SIMMS, JAMES KENNETH (M. '41), With United Fruit Co., 1 Federal St., Room 1039, Boston (Res., 54 Arapahoe Rd., West Newton), Mass.

SMITH, LAWRENCE TALMA (M. '41), Capt., Corps of Engrs., U.S. Army, Military Intelligence Officer, Intelligence Office, S-2, Camp Headquarters, Camp Grant, Ill.

SMITH, ROBERT DEMPSTER (Jun. '40), Levelman, Gen. Constr. Dept., Pacific Gas & Elec. Co., P. G. and E. Tunnel, Alta, Calif.

SMITH, WILLIAM ELMER (Assoc. M. '40), Asst. Engr., Commerical Development Dept., B. and O. R.R., 1104 B. and O. R.R. Bldg., Baltimore (Res., 629 Plymouth Rd., Catonsville), Md.

SPARKS, THOMAS CARR (Assoc. M. '41), Industrial Engr., B. and O. R.R., 1104 B. and O. Central Bldg., Baltimore (Res., 204 Rosewood Ave., Catonsville), Md.

STIRLING, VINCENT REYNOLDS (M. '41), Senior Engr., Navigation Section, U.S. Engr. Office, Massena, N.Y.

STUCK, RAYMOND WILBER (M. '41), Prin. Engr., Corps of Engrs., U.S. Army, 90 Church St., New York, N.Y. (Res., 195 Prospect St., East Orange, N.J.)

STUTZ, CLIFFORD NOEL (Assoc. M. '41), Asst. Cons. Engr., J. J. Woltmann, 314 Unity Bldg. (Res., 1308 North Rosney), Bloomington, Ill.

SULTENFUSS, JOHN HERMAN (Jun. '40), Gen. Contr., Wm. I. Sultenfuss, 803 James St., Tampa, Fla.

SWIFT, WILLIAM OLIVER, JR. (Jun. '41), Structural Engr., Asst. Secy., Austin Brothers Structural Steel Co., 1815 Coombs St. (Res., 6112 Martel St.), Dallas, Tex.

TAYLOR, LESLIE SEYMOUR (Assoc. M. '40), Care, U.S. Engr. Office, 403 Chamber of Commerce Bldg., Pittsburgh, Pa.

TINANT, CHARLES HENRY JOHN, JR. (Jun. '40), Field Clerk, Northwestern Eng. Co., Rapid City (Res., Lakeview), S.Dak.

VALLEI, QUINTO (Jun. '41), 11 North Blvd., Richmond, Va.

WANAMAKER, WILLIAM WESLEY (M. '41), Maj., Corps of Engrs., U.S. Army, Southwestern Div., Cotton Exchange Bldg., Dallas, Tex.

WATSON, WILL PAUL (Assoc. M. '41), Mgr., The Hamilton Gravel Co., 406½ First National Bank, Hamilton, Ohio.

WILSON, FRANCIS JUNNINGS (M. '41), Maj., Corps of Engrs., U.S. Army, Care, Office, Chf. of Engrs., Washington, D.C.

WILSON, ROBERT BROWN (Jun. '40), Junior Stress Analyst, Glenn L. Martin Co., Middle River (Res., 935 North Calvert St., Baltimore), Md.

MEMBERSHIP TRANSFERS

ARNE, I. CHRISTIAN (Jun. '36; Assoc. M. '41), With Erection Dept., Chicago Bridge & Iron Co., 1305 West 105th St. (Res., 1545 West 100th St.), Chicago, Ill.

BANKS, HARVEY OREN (Jun. '30; Assoc. M. '41), Asst. Hydr. Engr., State Div. of Water Resources, 803 State Bldg., Los Angeles, Calif.

BITNER, MELVILLE SPERRY (Jun. '28; Assoc. M. '36; M. '41), Associate Engr., Special Eng. Div., The Panama Canal, Diablo Heights, Canal Zone.

CHRISTIANI, HENNING OLDENBURG (Jun. '36; Assoc. M. '41), Engr., Christiani & Nielsen, 80 Broad St., New York, N.Y.

CREASY, DONALD CRAMPTON (Jun. '31; Assoc. M. '41), Dist. Operating Engr., Wm. A. White & Sons, 51 East 42d St. (Res., 55 West 11th St.), New York, N.Y.

DENNIS, RICHARD WHITING (Jun. '33; Assoc. M. '41), Engr., Transmission, Southern California Edison Co., Ltd., 605 West 5th St., Los Angeles (Res., 4224 Beck Ave., North Hollywood), Calif.

FLINSCH, HAROLD VON NEUFVILLE (Jun. '37; Assoc. M. '41), Asst. Prof., Civ. Eng., Bucknell Univ. (Res., 1005 St. Louis St.), Lewisburg, Pa.

GONZALEZ, MANUEL FRANCIS (Jun. '33; Assoc. M. '41), Supt., Smith Eng. & Constr. Co., Box 1831, Pensacola, Fla.

GRAMSTORFF, EMIL ANTON (Jun. '23; Assoc. M. '24; M. '41), Prof., Civ. Eng., Northeastern Univ., 360 Huntington Ave., Boston, Mass.

GUERIN, GEORGE VINCENT, JR. (Assoc. M. '30; M. '41), Bridge Engr., G. N. Ry., 4th and Jackson Sts. (Res., 947 Fairmount Ave.), St. Paul, Minn.

HOWELL, JOHN TUDHOPE (Jun. '33; Assoc. M. '41), Associate Engr., The Panama Canal, Box 585, Diablo Heights, Canal Zone.

JANVRIN, PHILIP EUGENE (Jun. '39; Assoc. M. '41), 1st Lt., Corps of Engrs., U.S. Army, Office P.M.S. and T, Univ. of Illinois, Champaign, Ill.

JOHNSON, HORACE ALLISON (Jun. '30; Assoc. M. '41), Asst. Engr., U.S. Engr. Dept., 751 South Figueroa St., Los Angeles, Calif.

JOVENE, NICHOLAS ANGELO (Jun. '30; Assoc. M. '40), Lt., U.S. Army, 105th Field Artillery, Fort McClellan, Ala.

KETCHUM, SMITH ADRON (Jun. '33; Assoc. M. '40), Asst. Engr., U.S. Bureau of Reclamation, Redding, Calif.

KUYKENDALL, AUBREY LEON (Jun. '37; Assoc. M. '40), Lt. (jg), C.E.C., U.S.N.R., Navy Yard, Brooklyn, N.Y.

LEFEVER, KENNETH WINANS (Jun. '17; Assoc. M. '28; M. '41), Civ. Engr., 302 Gazette Bldg., Little Rock, Ark.

MASK, WALTER SHARMAN (Jun. '34; Assoc. M. '41), 220 South Jackson St., Americus, Ga.

PAPANDREA, NATALE NED (Jun. '33; Assoc. M. '41), Civ. Engr. and Land Surveyor, 25 Erwin Pl., West Orange, N.J.

RABUCK, ARTHUR JACOB (Assoc. M. '28; M. '41), City Planning and Zoning Consultant, 5123 West Wisconsin Ave., Milwaukee, Wis.

RIVIERE, JAMES ANDREW (Jun. '26; Assoc. M. '32; M. '41), Asst. Div. Engr., State Road Dept., Box 540, De Land, Fla.

SCHEVE, CARL JULIUS (Jun. '30; Assoc. M. '41), Lt., C.E.C., U.S.N., Naval Operating Base, Norfolk, Va.

STIMPSON, CLARENCE AMOS (Assoc. M. '40; M. '41), Senior Engr., Jensen, Bowen & Farrell, 209 Michigan Theatre Bldg., Ann Arbor, Mich.

THOMPSON, ISADORE (Jun. '31; Assoc. M. '41), 129 Birch St., Redwood City, Calif.

WILLIAMS, NORMAN FERDINAND (Assoc. M. '30; M. '41), With Commonwealth & Southern Corp., Alabama Power Bldg., Birmingham, Ala. (Res., 1408 Riverview Rd., Chattanooga, Tenn.)

REINSTATEMENTS

FRENCH, WILLIAM ALLEN, Assoc. M., reinstated Apr. 4, 1941.

HURD, CHARLES HENRY, M., reinstated Mar. 18, 1941.

MARTYN, HENRY JAMES, Affiliate, reinstated Mar. 10, 1941.

SIMMONS, DONALD JACKSON, Assoc. M., reinstated Mar. 20, 1941.

STREANDER, PHILIP BERTRAM, M., reinstated Mar. 18, 1941.

WILHELM, FREDERICK EDWARD, M., reinstated Mar. 20, 1941.

RESIGNATIONS

FRYE, DONALD EDWARD, Jun., resigned Apr. 1, 1941.

MCKEE, ROBERT WILSON, Jun., resigned Mar. 24, 1941.

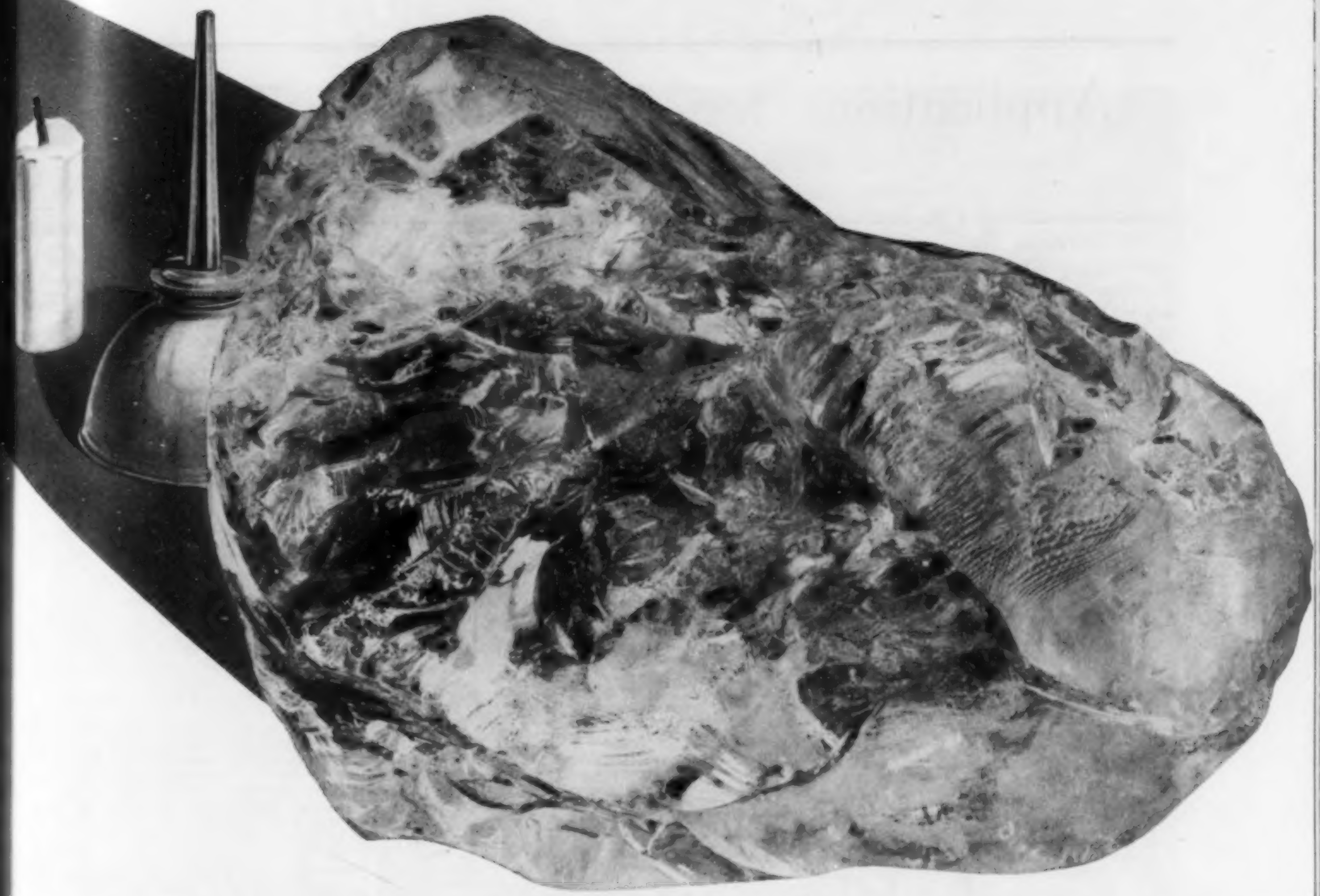
ORBANOWSKI, HORST HANS, Jun., resigned Apr. 4, 1941.

SANDS, ROBERT LAWRENCE, M., resigned Mar. 10, 1941.

STEPHENS, JOHN LANDERKIN, Jun., resigned Apr. 8, 1941.

VAN LOBEN SELS, MAURITS JUST, Jun., resigned Mar. 27, 1941.

WAITE, GEORGE THEODORE, Assoc. M., resigned Mar. 31, 1941.



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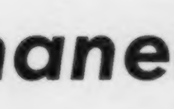

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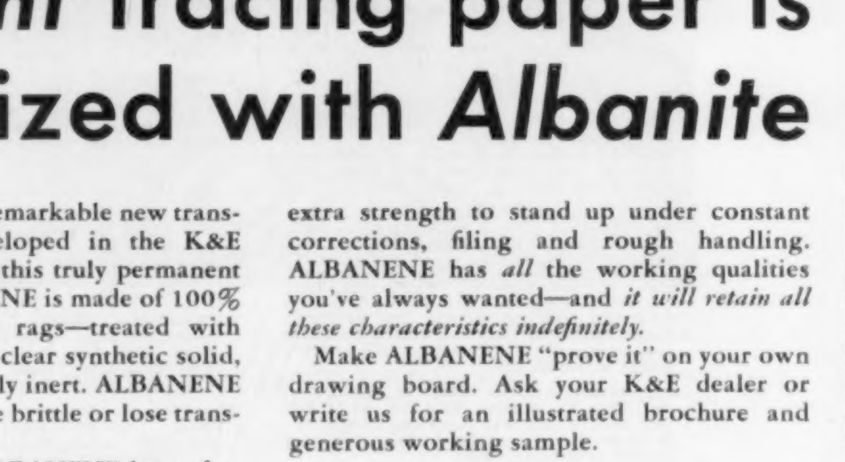


Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

May 1, 1941 — Number 5

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

Adams, Ernest Newbury, Worcester, Mass. (Age 51) (Claims RCM 27.0) 1928–1932 and 1935 to date Dist. Engr., American Inst. of Steel Constr., Inc.; in the interim Cons. Engr. (private practice).

Austin, Fred Harrison (Assoc. M.), Webster City, Iowa. (Age 54) (Claims RCA 3.1 RCM 24.2) Aug. 1918 to date with Currie Eng. Co., at present Secy.-Treas., on design and supervision of construction of sewers, sewage-treatment plants, etc.

Boyle, Eric John, St. George, Barbados. (Age 37) (Claims RCA 6.0 RCM 6.0) Nov. 1939 to date Chf. Engr., Central Road Board; previously Asst. Engr. and Chf. Asst. Engr., etc., with Coode, Wilson, Mitchell and Vaughan-Lee, Cons. Engrs. of London, England, on work in B.W.A. and B.W.I.

Cajanus, Carl Arvid, Wisconsin Rapids, Wis. (Age 53) (Claims RCA 5.7 RCM 14.3) May 1934 to date City Engr.; previously Cons. Engr. (private practice), Menasha, Wis.

Canton, John Axtell, Belmont, Mass. (Age 50) (Claims RCA 3.9 RCM 15.4) Jan. 1921 to date with Boston Elevated Ry., as Draftsman, Designer, Structural Engr., and (since Dec. 1940) Designing Engr.

Cather, LeRoy Heywood (Assoc. M.), Chicago, Ill. (Age 43) (Claims RCA 3.1 RCM 14.7) Dec. 1929 to date Vice-Pres., Charles DeLeuw & Co.

Clark, George Edward, Washington, D.C. (Age 47) (Claims RCA 10.0 RCM 8.7) 1928 to date with Dept. of Interior, Div. of Public Bldgs. and Parks (National Capital Parks) in various capacities; since Jan. 1940 as Chf., Repair & Constr. Div.

Dill, Frederick Hayes (Assoc. M.), Sewickley, Pa. (Age 35) (Claims RCA 2.0 RCM 5.0) July 1929 to date with American Bridge Co., in Drafting, Rate and Mech. Eng. Depts., at present as Welding Engr.

Fahy, Joseph Augustine (Assoc. M.), Washington, D.C. (Age 58) (Claims RC 27.6) July 1923 to date with Veterans Administration as Supt. of Constr., Superv. Supt. of Constr., and (since July 1934) Chf., Project Supervision and Constr. Service.

Feldman, Edmund Burke (Assoc. M.), Salt Lake City, Utah. (Age 46) (Claims RCA 6.3 RCM 15.6) March 1940 to date in private practice as Cons. Structural Engr.; previously with PWA as Engr. Examiner, Chf. Engr., Senior Engr., and Asst. to Regional Engr.

Finkbeiner, Carleton See (Assoc. M.), Toledo, Ohio. (Age 42) (Claims RCA 5.1 RCM 10.8) July 1935 to date with Champe, Finkbeiner & Associates as Partner, Proprietor, and (since Jan. 1940) Senior Partner.

Fulton, Edward Arthur, St. Louis, Mo. (Age 42) (Claims RCA 1.3 RCM 14.9) Jan. 1932 to date in private practice, until Jan. 1936 as member of firm, Kinsey Eng. Co., St. Louis, Mo., and Pekin, Ill., and (since Jan. 1936) as Edward A. Fulton.

Goebel, Andrew Scheihing, Savannah, Ga. (Age 48) (Claims RCA 3.7 RCM 18.2) Feb. 1933 to date City Engr., and Chairman, City Planning Board, Eng. Dept., Savannah.

Grant, Elberth Rueben, St. Louis, Mo. (Age 42) (Claims RCA 2.8 RCM 13.4) June 1928 to Jan. 1930 Engr., and Jan. 1930 to date Partner, Sverdrup & Parcel, Cons. Engrs.

Hurd, Harold Waller, Albuquerque, N.Mex. (Age 43) (Claims RCA 11.4 RCM 6.0) May 1935 to date with SCS as Dist. or Area Engr., and (since May 1940) with Project Plans Div. as Soil Conservationist (Party Leader), Rio Grande flood-control survey.

Johnson, Bernard David (Assoc. M.), Elkins, W.VA. (Age 48) (Claims RCA 7.6 RCM 8.9) Sept. 1922 to date with West Virginia State Road Comm., Charleston, W.Va., as Chf. of Party, Instrumentman, Inspector, Res. Engr., Asst. Dist. Engr., Dist. Engr., and (since Dec. 1937) Constr. Engr.

Kirby, Kyrel Ellsworth (Assoc. M.), Galveston, Tex. (Age 54) (Claims RCA 16.8 RCM 8.3) June 1940 to date Asst. Engr., Galveston, Houston and Henderson R.R. Co.; previously Asst. Chf. Draftsman on flood control, Supt. and Timekeeper on road construction, WPA; Land Appraiser and Asst. Engr., Gulf, Colorado and Santa Fe Ry.

Lesh, Harry William (Assoc. M.), Brooklyn, N.Y. (Age 45) (Claims RCA 8.9 RCM 14.9) Feb. 1940 to date Cons. Engr., New York City; previously Res. Engr. Inspector, PWA; Estimating Engr., Chanin Constr. Co., Inc.; Partner, Blumenthal & Lesh, Foundation Contrs.

McNaughton, William Carlton (Assoc. M.), New York City. (Age 49) (Claims RCA 1.5 RCM 23.3) June 1940 to date Asst. Engr., New York City Transit System; previously with I.R.T. Co., as Asst. Engr., and Res. Engr.

Nash, Charles Woods (Assoc. M.), Wenatchee, Wash. (Age 39) (Claims RCA 9.4 RCM 4.7) Feb. 1939 to date Cons. Engr. (private practice); previously with Washington State Highway Dept. as Res. and Locating Engr., Dist. State Aid Engr., and Dist. Maintenance Engr., etc.

Nisbet, Alexander Gordon, New York City. (Age 44) (Claims RCA 4.0 RCM 8.7) Jan. 1941 to date with Ebasco Services, Inc., Engrs., as Concrete Designer and Checker; previously Structural Checker, M. W. Kellogg Co.; Structural Engr., Constr. Div., New York World's Fair, Inc.; Superv. Draftsman, Div. of Design, and Asst. Supt., Div. of Constr., Dept. of Parks.

Norwood, Earl Ellis, Chicago, Ill. (Age 37) (Claims RCA 4.7 RCM 10.5) Nov. 1934 to date with E. J. Albrecht Co., Gen. Contrs., in complete charge of heavy engineering construction projects.

Reyes, Enrique Garcia, Bogota, Colombia. (Age 39) (Claims RCA 8.7 RCM 8.0) Sept. 1937 to date with Colombian Govt. (under contract) on design of Central Ry. Station (National Ry. Council), also Prof. of Bridges and Concrete, School of Eng., National Univ. of Bogota; previously Engr. in charge of construction of urban section of Connecting Ry., Madrid.

Richardson, Frederick Hosea (Assoc. M.), Salt Lake City, Utah. (Age 58) (Claims RCA 10.4 RCM 13.8) June 1922 to date with Portland Cement Association as Field Engr., Dist. Engr., and (since July 1932) Cons. Engr.

Shappert, Frederick William, Jr. (Assoc. M.), Belvidere, Ill. (Age 39) (Claims RCM 15.5) June 1929 to date Pres., Shappert Eng. Co.

Thomas, David Pyper, Salt Lake City, Utah. (Age 41) (Claims RCA 8.5 RCM 7.0) Sept. 1940 to date 1st Lieut., U.S. Army, at present Asst. Q.M. and Utility Officer at Ogden Air Depot; March–June 1940 Engr. with Ryberg Bros., Bldrs.; previously Engr., Salt Lake City Board of Education.

Webb, William Thayer (Assoc. M.), Washington, D.C. (Age 42) (Claims RCA 2.5 RCM 10.6) Jan. 1937 to date Engr., 1 year with Thos. W. Marshall, and since Jan. 1938 with Thos. W. Marshall & James M. Gongwer; previously Prin. Asst. to Seward Charles, Washington, D.C.

Wetzler, Thomas Edward (Assoc. M.), Peoria, Ill. (Age 55) (Claims RCA 4.7 RCM 14.2) May 1937 to date City Engr., Peoria, Ill.; previously Engr., Illinois Highway Dept.

Witt, Joshua Chitwood, Chicago, Ill. (Age 56) (Claims RCM 26.6) 1939 to date Technical Service Manager, Marquette Cement Mfg. Co.; previously Director of Research, Universal Atlas (formerly Portland) Cement Co.

APPLYING FOR ASSOCIATE MEMBER

Ashton, Frank William (Junior), Rock Island, Ill. (Age 32) (Claims RCA 5.8) Nov. 1933 to date with U.S. Engrs., as Senior Draftsman, Jun. Engr., and (since Oct. 1935) Asst. Engr.

Breedlove, John Cromwell, Coulee Dam, Wash. (Age 33) (Claims RCA 9.3) June 1934 to date with U.S. Bureau of Reclamation as Senior Engr. Draftsman, Asst. Engr., and (since May 1938) Associate Engr.

Burdman, Irving, San Diego, Calif. (Age 34) (Claims RCA 6.0) July 1940 to date Associate Civ. Engr., Public Works Dept., 11th Naval Dist.; previously Asst. Civ. Engr., U.S. Engr. Office; with Metropolitan Water Dist. of Southern California on Colorado River Aqueduct construction as Jun. Engr., Concrete Inspector, and Div. 5 Office Engr.

Cahn, Charles Alexander (Junior), New Haven, Conn. (Age 30) (Claims RCM 6.6) Sept. 1934 to date in private practice under title, Office of Alexander Cahn, on property-line surveys, design and supervision of construction work, etc.

Carlson, Albert Walter, San Benito, Tex. (Age 30) (Claims RCA 1.9) Jan. 1939 to date Jun. Engr., International Boundary Comm., United States and Mexico; previously Civ. Engr. and Foreman, James P. O'Keefe, Contr., Chicago, Ill.; Civ. Engr., WPA Project 2667.

CLIFFE, LUTHER ELIOT (Junior), Coulee Dam, Wash. (Age 32) (Claims RCA 4.6) Sept. 1933 to date with U.S. Bureau of Reclamation as Rodman, Levelman, Jun. Engr., Asst. Engr., and (since March 1940) Associate Engr.

DEMBOSKI, HENRY (Junior), Rockwood, Tenn. (Age 32) (Claims RCA 5.3) May 1935 to date with TVA as Eng. Aide, Jun. Hydr. Engr., and (since April 1939) Asst. Hydr. Engr.

DEWEESE, RALPH W, Clarksdale, Miss. (Age 34) (Claims RCA 2.0) Oct. 1935 to date on drainage work at CCC Camps as Engr., and (since June 1940) Technician.

DOWNWARD, PAUL HOLLINGSWORTH, Lansdowne, Pa. (Age 36) (Claims RCA 2.7 RCM 1.3) March 1941 to date Senior Structural Engr., Frankford Arsenal, U.S. Army, Philadelphia; previously Structural Engr., Wunder & Werner; Structural Designer and Detailer, Rosslyn Steel & Concrete Co., Washington, D.C.; with Heyman & Goodman Co., Inc., Hart & Early Co., Inc., C. Goodman, and New York State Transportation Comm.

DUNCAN, CHARLES FREEMAN (Junior), Richmond, Va. (Age 32) (Claims RCA 3.5) Nov. 1929 to date with U.S. Engrs., as Jun. Engr., Asst. Engr., Capt., Corps of Engrs. Reserve, and (since March 1941) Asst. Engr., Office of Div. Engr., South Atlantic Div., War Dept.

DVORAK, RUDOLPH, Maspeth, N.Y. (Age 32) (Claims RCA 6.8) June 1934 to date with Consolidated Edison Co. of New York, Inc., as Eng. Asst., Supervising Draftsman, Supervisor of entire coordinating and drafting group, and (since July 1938) Designer.

FREMOUW, GERRIT DANGREMOND, Newark, N.Y. (Age 32) (Claims RCA 8.8) June 1936 to date with WPA, as Wayne County Engr. and Supt., Asst. Field Engr., and (since April 1939) Dist. Director of Operations, WPA, Rochester and Monroe Counties.

FRUHAUF, BEDRICH, New York City. (Age 34) (Claims RC 4.4 D 5.3) July 1939 to date Research Associate in Civ. Eng., Soil Mechanics Laboratory, Columbia Univ.; previously Research Engr. and Geologist, Spencer, White and Prentis, Inc.; research student at Univ. of Colo., and at Harvard Univ.; Civ. Engr., Soils Mechanics and Foundation Laboratory, Paris, France.

GARDNER, LEIGH OWEN (Junior), Phoenix, Ariz. (Age 28) (Claims RCA 4.3 RCM 1.5) July 1938 to date Designing Engr., Headman, Ferguson & Carollo, Cons. Engrs.; previously with City of Phoenix as Estimator and Designing Engr.

GAYLORD, CHARLES NELSON (Junior), Clemson, S.C. (Age 32) (Claims RCA 3.2 RCM 0.5) Sept. 1940 to date Instructor in Civ. Eng., Clemson (S.C.) Agricultural and Mechanical Coll.; previously at Hampton (Va.) Inst., as Instructor, Asst. Prof., and Associate Prof.

HECKATHORN, JOHN HENRY (Junior), Quantico, Va. (Age 32) (Claims RCA 4.8 RCM 0.4) Jan. 1939 to date Asst. Civ. Engr., Public Works Dept.; previously Senior Eng. Draftsman, U.S. Engr. Office.

HERKENHOFF, GORDON EMMETT, Santa Fe, N.Mex. (Age 34) (Claims RC 10.5 D 4.5) Aug. 1935 to date State Director, Div. of Operations, WPA.

HESTER, QUINCY ADAMS, JR., Baton Rouge, La. (Age 35) (Claims RCA 7.8) Dec. 1925 to date with Louisiana Highway Comm., as Draftsman, Bridge Detailer, etc., and in Bridge and Road Depts.

HOWELL, HERBERT HOWARD, Columbus, Ohio. (Age 30) (Claims RCA 5.6 RCM 1.8) March 1940 to date Dist. Airport Engr., Civil Aeronautics Authority; previously with WPA, Oklahoma, on airport work, etc.

JACKSON, WILLIAM COYT, Santa Fe, N.Mex. (Age 33) (Claims RCA 4.0) April 1931 to date with New Mexico Highway Dept., as Computer, Draftsman, and (since Oct. 1934) Highway Designer.

JENNINGS, ROY TURNEY (Junior), Auburn, Ala. (Age 32) (Claims RCA 3.2) Sept. 1940 to date Asst. Prof. of Civ. Eng., Alabama Polytechnic Inst.; previously Asst. Engr. with City of Auburn, and Knoxville (Tenn.) Iron Co.; Instructor in Civ. Eng., North Dakota Agricultural Coll.; Engr., Aluminum Co. of America.

JOHNSON, ALFRED EUGENE, Harrison, Ark. (Age 33) (Claims RCA 5.4 RCM 1.7) Jan. 1941 to date Field Engr. (Roads), Benham Eng. Co.; previously with Arkansas Highway Dept., as Rodman, Levelman, Instrumentman, Field Engr., Prin. Draftsman, Asst. Res. Engr., Res. Engr., and Designer.

JORDAN, JOSEPH ALEXANDER, New York City. (Age 44) (Claims RCA 16.5 RCM 4.0) Sept. 1940 to date Chf. Engr., Healy-Giardino, Inc., Queens, N.Y.; previously Chf. Constr. Engr., T. M. Flanaghan, Reading, Pa.; Chf. Engr., Candeloro Constr. Corporation; associated with Arthur R. Rule; Vice-Pres. and partner, Tripp Constr. Co.

KEESE, MAURICE JEFFERIES, Baltimore, Md. (Age 43) (Claims RCA 18.2) June 1929 to date with Kalman Steel Co., Inc. (purchased by Bethlehem Steel Co. in Aug. 1931) as Dist. Engr., and (since Aug. 1931) Engr.

KEY, OTIS NATHANIEL, Corpus Christi, Tex. (Age 41) (Claims RCA 10.3 RCM 6.5) July 1940 to date with Brown-Bellows Columbia Constr. Co. as Chf. of Party on construction at Naval Air Station; previously in private practice; with Texas Pacific R.R., Big Spring, Tex.; with PWA, Washington, D.C., and Fort Worth, Tex.

KROLL, CHARLES LESLIE, Baltimore, Md. (Age 35) (Claims RCA 9.7) Oct. 1924 to date (except May 1932 to Dec. 1933) with Baltimore & Ohio R.R., as Rodman, Inspector, Transitman, Levelman, and (since Aug. 1936) Field Engr.

LARSEN, HENRY JOHN, Pittsburgh, Pa. (Age 29) (Claims RCA 1.7) Aug. 1936 to Oct. 1940 with Hunting, David & Dunnells, successively as Draftsman, Chf. Draftsman, and finally Asst. to Prof. Dunnells; at present Asst. Engr., Westinghouse Elec. & Mfg. Co.

LEBA, THEODORE, JR. (Junior), Memphis, Tenn. (Age 28) (Claims RCA 2.2 RCM 0.9) Sept. 1939 to date with S & W Constr. Co. as Field and Planning Engr., and (since Sept. 1940) Chf. Constr. Engr. for company and associates at Camp Livingston, Alexandria, La.; previously Jun. Engr., U.S. Geological Survey; Designer and Draftsman, Foster-Wheeler Corporation, and Board of Design, Metropolitan Life Insurance Co.; Draftsman, Gibbs & Hill, Inc., Cons. Engrs., New York City.

LEPP, JOHN (Junior), Anniston, Ala. (Age 33) (Claims RCA 1.2 RCM 1.4) Nov. 1940 to date 2d Lieut., QMC, U.S. Army; previously Jun. Highway Bridge Engr., PRA, Washington, D.C.; Draftsman, Senior Draftsman, and Jun. Engr. (Civil), U.S. Engr. Office.

LOVE, THAD SPENCE, Houston, Tex. (Age 33) (Claims RCA 7.6 RCM 1.1) April 1939 to date Engr., Haile & McClendon, Cons. Engrs.; previously Jun. Engr., FSA, Dallas; Senior Draftsman, Harris County Eng. Dept., Houston.

MACKINTOSH, ALBYN, Los Angeles, Calif. (Age 32) (Claims RCM 2.8) Jan. 1937 to date (except 4 months in 1938) with Gen. Eng. Service Co., as Draftsman, Designer, Chf. Structural Designer, and since April 1940 Chf. Structural Designer and Owner and Chf. Engr. of Surveying Dept.; previously Instructor in Civ. Eng., Northeastern Univ.

MATZKE, ARTHUR EDWARD (Junior), New York City. (Age 32) (Claims RCA 5.6) June to Oct. 1930 and May 1931 to Dec. 1933 (intermittently) Testing Engr., Materials Testing Laboratory, and Dec. 1933 to date Research Asst., Instructor, and Associate, Civ. Eng. Dept., Columbia Univ.

MICKLEWRIGHT, WILLIAM HENRY, Rutherford, N.J. (Age 31) (Claims RCA 3.4 RCM 0.2) Oct. 1940 to date Draftsman-Designer, Phelps Dodge Corporation, New York City; previously Draftsman-Designer, Republic Fireproofing Co.; Designer, Pennsylvania Turnpike Comm., Harrisburg, Pa.; Draftsman, Port of New York Authority.

NELSON, WILLIAM BONNEAU, Hernando, Miss. (Age 32) (Claims RCA 8.5 RCM 1.3) June 1929 to date with U.S. Engr. Dept. as Inspector, Jun. Engr., Asst. Engr., and (since Feb. 1940) Associate Engr., Vicksburg Dist.

NOVARO, JOSEPH ANGELO, New Haven, Conn. (Age 36) (Claims RCA 6.5 RCM 1.5) March 1930 to date Asst. Engr. and Res. Engr., until March 1938 with Blair & Marchant, Inc., Cons. Engrs., and since March 1938 with Clarence M. Blair, Inc., Cons. Engrs.; 1st Lieut., Officers' Reserve Corps.

OAKES, CECIL KOPPREL, Diablo Heights, Canal Zone. (Age 34) (Claims RCA 3.8) June 1940 to date Jun. and Asst. Engr., The Panama Canal; previously with U.S. Engr. Dept., New Orleans, La., as Surveyman, Eng. Aide, and Jun. Engr.

OTTO, ARTHUR LOUIS (Junior), West Orange, N.J. (Age 31) (Claims RCA 2.4) Nov. 1939 to date Structural Designer, Phelps Dodge Corporation, New York City; previously Structural Designer, Tunnel Div., Pennsylvania Turnpike Comm.; Draftsman with Port of New York Authority, and with Waddell & Hardesty, both of New York City.

PARKER, HOMER MARTIN, Baltimore, Md. (Age 49) (Claims RCA 13.1) 1919 to date with Portland Cement Association, 1/2 year as Inspector, and remainder of time Field Engr.

PENDERGRASS, JOHN THOMAS, Fort Smith, Ark. (Age 37) (Claims RCA 13.3) Jan. 1941 to date on national defense work as Engr. of Railroads; 1940 to Jan. 1941 Res. Engr. on highway construction, Arkansas State Highway Comm.; previously Chf. Engr. and Gen. Supt. in charge of operations, Acme Semi-Anthracite Coal Co.

PRUIT, JOHN ANDIE, Abilene, Tex. (Age 39) (Claims RCA 10.6 RCM 5.5) April 1938 to date member of firm, French & Pruit Co.; previously with Texas Highway Dept., as Concrete Paving Inspector, Locating Engr., Res. Engr., Acting Res. Engr., and Asst. Res. Engr.; Dist. Supervisor, Div. of Operations for WPA, Dist. No. 18.

REID, KEITH CAMERON (Junior), Honolulu, Hawaii. (Age 32) (Claims RCA 3.1 RCM 3.2) Sept. 1937 to date Structural Engr. and Designer with Guy N. Rothwell, Archt.; previously Designer with Jas. Arnott & Son, San Francisco, Calif.

ROBERTS, WESLEY, San Benito, Tex. (Age 36) (Claims RCA 5.0) June 1936 to date with International Boundary Comm., United States and Mexico, as Eng. Draftsman, and (since June 1939) Chf. Inspector of Eng. Constr.; previously Constr. Engr., Coastal Refineries, Inc.

ROBINSON, HAMILTON EDWIN, Huntington Park, Calif. (Age 52) (Claims RCM 22.2) May 1936 to date City Engr., Huntington Park, Calif.; previously in private practice of general engineering, contracting and building, also consulting.

ROCKWOOD, HENRY (Junior), Fort Worth, Tex. (Age 31) (Claims RCA 2.9 RCM 1.6) Oct. 1937 to date with U.S. Weather Bureau as Asst. Hydrologic Engr., and (since May 1940) Associate Hydrologic Engr.; previously with Sec. of Watershed Studies, SCS, Washington, D.C., as Jun. Hydr. Engr., and Asst. Hydr. Engr.

RYAN, ALFRED JOSEPH (Junior), Knoxville, Tenn. (Age 32) (Claims RCA 4.2 RCM 2.0) Aug. 1936 to date with TVA as Jun. Structural Engr., Prin. Engr. Draftsman, and (since Oct. 1937) Asst. Structural Engr.

RYAN, DAVID EUGENE KEVIN, Boise, Idaho. (Age 32) (Claims RCA 1.5) Feb. 1941 to date Chf. of Party with U.S. Army Engrs.; previously with State of Idaho as Instrumentman, Levelman and Inspector, Clerk of Works, etc.; on CCC duty as 1st Lieut., Coast Artillery Reserve; Jun. Engr., City of Duluth, Minn.

SANTI, MARK GIOVACCHINO (Junior), Alexandria, Va. (Age 32) (Claims RCA 6.3) Oct. 1940 to date Asst. Civ. Engr., Civil Aeronautics Administration; previously Jun. Engr., Federal Power Comm., Washington, D.C.; Asst. Engr. Aide, and Jun. Hydr. Engr. with SCS.

SILVESTRI, JOSEPH PAUL (Junior), San Francisco, Calif. (Age 32) (Claims RCA 6.8) Jan. 1940 to date Constr. Engr., San Mateo (Calif.) Feed & Fuel Co.; previously Timekeeper and Supt., Union Paving Co., San Francisco, Calif.

SIMS, JOHN PETER (Junior), New Boston, Pa. (Age 32) (Claims RCA 4.1 RCM 3.3) May 1937 to date with Pennsylvania Turnpike Comm., as Chf. of Party, and (since Feb. 1939) Chf. of Surveys; previously with Sims Bros., Inc., St. Clair, Pa.

SPIRZ, WILLIAM HAIBER, San Rafael, Calif. (Age 38) (Claims RCA 4.7) Sept. 1933 to Nov. 1936 and March 1937 to date with California Div. of Highways as Senior Eng. Office Aid, Jun. Bridge Engr., Asst. Bridge Engr., Engr., and (since July 1940) Asst. Res. Engr. (with rating of Jun. Bridge Engr.).

STODDARD, HOWARD AUGUSTUS (Junior), Modesto, Calif. (Age 27) (Claims RCA 2.9) Sept. 1936 to date with U.S. Bureau of Reclamation in various capacities, since Sept. 1939 Asst. Engr.

TWIGGAR, EDWARD VERNON (Junior), Widnoon, Pa. (Age 32) (Claims RCA 5.5 RCM 4.2) June 1931 to date with The Dravo Corporation, Pittsburgh, Pa., as Estimator, Asst. Supt. of Constr., Engr. and Night Supt. of Constr., and (since April 1939) Supt.

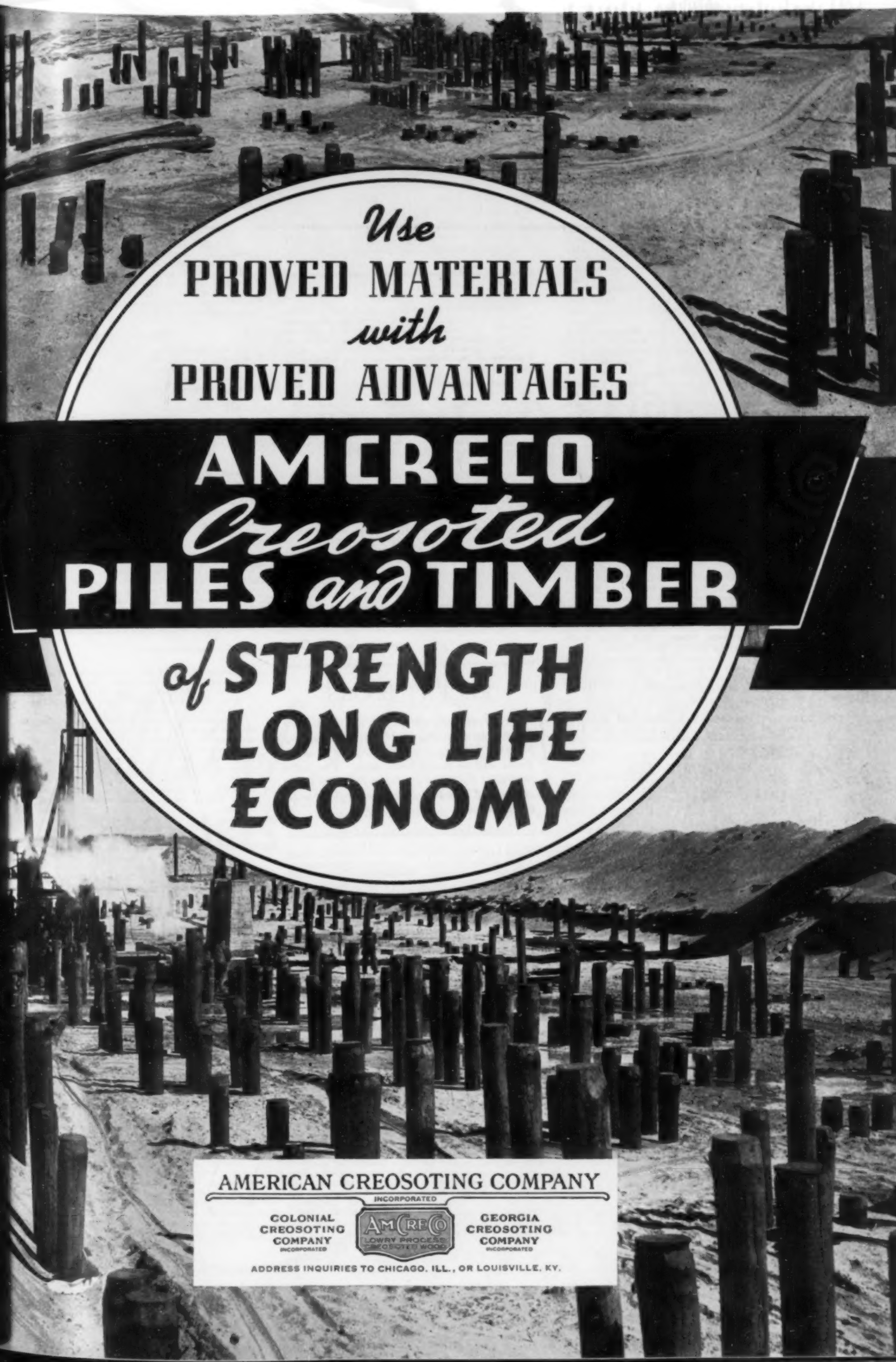
WALTON, GRAHAM, Madison, Wis. (Age 35) (Claims RCA 1.0) Sept. 1935 to date Instructor in Hydraulic and Sanitary Eng., Univ. of Wisconsin.

WHITMAN, WORSHAM CARROLL (Junior), Dallas, Tex. (Age 32) (Claims RCA 1.3) Feb. 1933 to date (intermittently) with Texas Highway Dept., in various capacities, and since Jan. 1940 as Field Engr., Dist. 18.

APPLYING FOR JUNIOR

CHASE, WILLIAM KENT, Redding, Calif. (Age 26) July 1940 to date Layout Man, with Couse & Saunders, Gen. Contrs.; previously Draftsman for L. B. Jameson, Archt.; Timekeeper and Layout Man with Barton-Malow Co., and Miller-Davis Co., both Gen. Contrs.

DOUGHERTY, JOHN ALBERT, Milwaukee, Wis. (Age 27) (Claims RCA 1.6) March 1941 to date Associate Engr. for Constructing Quarter-


Use
PROVED MATERIALS
with
PROVED ADVANTAGES
AMCRECO
Creosoted
PILES and TIMBER
of STRENGTH
LONG LIFE
ECONOMY
AMERICAN CREOSOTING COMPANY
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COLONIAL CREOSOTING COMPANY
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LOWRY PROCESS CREOSOTED WOOD
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master, Camp Blanding, Fla.; previously Engr. Inspector for Solomon & Keis, Cons. Engrs., Troy, N.Y.; Field Engr. for National Survey Service, Milwaukee, Wis.; Engr. Inspector, PWA, Washington, D.C.

GRIFFITH, JOHN MACK, Ann Arbor, Mich. (Age 26) Dec. 1939 to date Soils Testing and Soils Research Engr. for Prof. W. S. Housel (Research Consultant, Univ. of Michigan); previously Office Engr., City Engr.'s Office, Ann Arbor; Draftsman, Mississippi Highway Dept., Jackson, Miss.

HALES, ALBERT JOSEPH, Oakland, Calif. (Age 27) (Claims RCA 2.3) Aug. 1936 to date with Hersey Inspection Bureau as Inspector, Laboratory Technician, Concrete Technologist, and (since Aug. 1939) Concrete Technologist and Chf. Engr. of Tests.

HANSEN, VERNON JOHN, Sacramento, Calif. Age 26) (Claims RCA 1.5) July 1938 to date with U.S. Bureau of Reclamation as Computer and Jun. Engr.

HEGARTY, HUGH EMMET, North Plainfield, N.J. (Age 26) 1939 B.S. in C.E., Newark Coll. of Eng.; Sept. 1940 to date Instrumentman with Constr. Quartermaster, Ft. Hancock, N.J.; previously not on engineering.

PEREZ GUERRA, GUSTAVO LUIS, Caracas, Venezuela. (Age 25) 1938 Doctor in Mathematical and Physical Sciences, Central Univ. of Venezuela; Oct. 1936 to date with Water Works Div., The Ministry of Public Works, Venezuela, on student work as Asst. to Designer, and (since Oct. 1938) Asst. Engr.

REECE, GEORGE MATTHEW, PHILADELPHIA, Pa. (Age 27) (Claims RCA 2.0) Jan. 1941 to date Asst. San. Chemist, Dept. of Public Works, Bureau of Water; previously Research Associate, Dept. of Industrial Hygiene, Harvard School of Public Health; Asst. Engr., Bureau of San. Eng., Virginia State Health Dept.

SCHRENK, GEORGE STAEHLE, New Orleans, La. (Age 27) Nov. 1940 to date Jun. Engr. with Barnard, Godat & Heft, Cons. Engrs.; previously with Gulf Research & Development Co., Houston, Tex.

SPENCER, ERNEST LINCOLN, Medfield, Mass. (Age 27) Dec. 1939 to date Instructor in Civ. Eng., Northeastern Univ., Boston; Jun. Eng. Aide, Div. of Waterways, Massachusetts Dept. of Public Works; Asst. Engr., Jackson & Moreland, Engrs.; Transitman with Lewis W. Perkins, Hingham, Mass.; Jun. Eng. Aide, Parks Div., Metropolitan Dist. Comm.

VON SCHLATZER, ROBERT KARL, Balboa, Canal Zone. (Age 30) May 1931 to Oct. 1935, Sept. 1937 to July 1939 and Feb. 1941 to date with U.S. Bureau of Public Roads (now U.S. PRA), as Computer, Instrumentman, Chf. of Party, Aide to Office Engr., Senior Eng. Draftsman, Designer, and (since Feb. 1941) Asst. Highway Engr. at Panama; in the interim with U.S. Engrs., and with Special Eng. Div., The Panama Canal.

1940 GRADUATES

UNIV. OF MINN.
(B.C.E.)

	AGE
PRUSAK, BERNARD ROY	(22)

UNIV. OF OKLA.
(B.S. in Civ.Eng.)

BENSON, WALTER MERLE	(23)

1941 GRADUATES

STATE UNIV. OF IOWA
(B.S. in C.E.)

ULUSHAHIN, MUZAFFER OK	(23)

UNIV. OF MICH.
(B.S. in C.E.)

ADAMS, CHARLES MCDONALD	(25)
BARRETT, FERN WENDELL	(22)
FISHER, OWEN LLOYD	(22)
MCCLEER, PHILIP ARTHUR	(23)
RICKETTS, ALLAN TOWNSHEND, Jr.	(22)

COLL. OF CITY OF N.Y.
(B.C.E.)

BAUNACH, ALPHONSE	(22)
CUSTEN, ALLEN MORDECAI	(21)
DORFMAN, JOSEPH SAMUEL	(25)
FRIED, OSCAR FRANK	(21)
JAFFESS, HERBERT	(20)
LEVINE, MARTIN	(22)
NOVINSKY, MAX HAROLD	(21)
SCHWARTZ, MILTON	(22)
TOMANN, KENNETH JOHN	(20)

UNIV. OF WIS.
(B.S.)

BREM, GEORGE FRED, JR.	(22)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

Items are furnished by the Engineering Societies Personnel Service, 31 West 39th Street, New York, N.Y. Address replies to key number, care of New York office, unless Chicago, Detroit, or San Francisco office is designated. See page 141 of Society's 1941 Year Book for details of procedure.

CONSTRUCTION

CONSTRUCTION ENGINEER; M. Am. Soc. C.E.; New York license; 30 years in responsible charge of heavy construction as chief engineer and consulting engineer on construction of subways, sewers, highways, airports, and railroad yards; engineering accountant in complete charge of accounting on large building operations. C-834.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; age 37; engineering supervision of railroad and highway structures; 5 years of supervision of construction of new railroad and structures; 2 years in Asia; present employment for past 8 years, superintendent of construction on reinforced concrete dams, bridges, culverts, water control structures, sewer and water lines. Frame buildings. C-841.

DESIGN

CIVIL ENGINEER; M. Am. Soc. C.E.; age 48; graduate of Hungarian university; New York license; 17 years American experience in structural steel and concrete, design of buildings, bridges, railroads, and hydraulics; will accept permanent position anywhere in the United States; available on one month's notice. C-833.

CIVIL ENGINEER; Assoc. Am. Soc. C.E.; 38; married; college graduate; 16 years on the design and construction of bridges and appurtenant works, in steel company and other engineering offices; also experienced in design of light and heavy steel erection equipment, aerial conveyors, suspension bridges, and suspension systems. Employed; desires new location. C-837.

CIVIL ENGINEER; Assoc. M. Soc. C.E.; 30; married; B.S.C.E., 1932; M.S.C.E., 1940; 6 years design and construction and inspection of highways, water works, storm sewers, airport runways; 1 year research on soils and embankments; 2 years teaching drafting, highways, hydraulics, surveying, and drainage; desires responsible position. C-838.

EXECUTIVE

CIVIL ENGINEER—EXECUTIVE; Assoc. M. Am. Soc. C.E.; age 37; married; in charge of large land department; 9 years land acquisition, public relations, appraisal, and condemnation experience; 7 years on railroad construction; qualified land appraiser; real estate practice. Desires position as real estate and tax officer or right-of-way engineer. C-835.

MISCELLANEOUS

CIVIL ENGINEER; M. Am. Soc. C.E.; 45; M.C.E., Cornell University; established offices in Shanghai, Hongkong, and the war capital; desires to represent U.S. manufacturers of hydraulic turbines, sluice gates, construction equipment, instruments, and building materials. C-839.

RESEARCH AND TEACHING

ARCHITECTURAL ENGINEER; Jun. Am. Soc. C.E.; 28; B.S., 1934; M.S., 1936, architecture; M.S., 1938, architectural engineering; Ph.D. (major in architectural engineering, minor in engineering mechanics) expected in June 1941; registered architect; 3 years with architectural firms in this country and abroad; 4 years research and testing; faculty member in charge of timber research. Available July 1. C-836.

TEACHING

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; age 37; professional engineer (two states); desires assistant or associate professorship offering opportunity to develop highway and airport courses. Eastern location. Ten years teaching experience; five years highways, bridge construction, water works, and private practice. Now employed; available in September. C-840.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

AMERICAN PLANNING AND CIVIC ANNUAL 1940. Edited by H. James. American Planning and Civic Association, Washington, D.C., 1940. 278 pp., illus., $9\frac{1}{2} \times 6$ in., cloth, \$3.
The papers collected in this volume constitute a record of recent civic advance in the fields of planning, parks, housing, and neighborhood improvement. About half the material was prepared especially for the Annual; the remainder consists of the principal papers delivered at the 1940 National Conference on Planning and the nineteenth National Conference on State Parks, 1940.

DRAINAGE AND FLOOD-CONTROL ENGINEERING, 2 ed. By G. W. Pickels. McGraw-Hill Book Co., New York and London, 1941. 476 pp., illus., diagrs., charts, maps, tables, 9×6 in., cloth, \$4.
The improvement of small areas of cultivable land by under-drainage and the reclamation of large areas of wet and overflow lands by surface drainage and by flood control are discussed in this treatise. The new edition has been thoroughly revised, and the information acquired during the last fifteen years incorporated.

ELEMENTARY STRUCTURAL ENGINEERING. By L. C. Urquhart and C. E. O'Rourke. McGraw-Hill Book Co., New York, 1941. 348 pp., diagrs., charts, tables, 9×6 in., cloth, \$3.
Intended for use both as a text for non-civil engineering courses and as a manual for graduate engineers and architects, this book presents, first, the basic principles of structural mechanics and the more important properties of structural materials. Succeeding chapters cover the fundamental principles of structural theory and design in steel, timber, and concrete. Many examples have been worked out.

ENGINEERING REVIEW, STRUCTURAL STEEL AND REINFORCED CONCRETE. By C. Kandall. Cord Publishers, New York (147 Fourth Avenue), 1940. 162 pp., diagrs., charts, tables, $8\frac{1}{2} \times 5\frac{1}{2}$ in., cloth, \$2.50.
Fundamental theories of elementary structural design are briefly reviewed and illustrated by the solution of problems. The book thus serves as a reference and review text for practicing engineers and students. An appendix containing solutions of numerical problems in structural design given in the New York state examinations for licensed professional engineer makes it particularly useful for all examinations in structural design.

PRINCIPLES OF INLAND TRANSPORTATION, 3 ed. By S. Daggett. Harper & Brothers, New York, 1941. 906 pp., illus., diagrs., charts, maps, tables, $9\frac{1}{2} \times 6$ in., cloth, \$4.
Intended as a college text, this comprehensive work covers road, rail, water, air, and pipe line transport, chiefly in the United States. Early chapters present a brief historical survey and a consideration of transportation geography. Subsequent sections discuss rates, competition, labor and finance, relations of carriers with each other, and relations between carriers and users. The problems and practice of regulation have been given full consideration. This new edition has been thoroughly revised for current use.

SURVEYING, 2 ed. By H. Bouchard. International Textbook Co., Scranton, Pa., 1940. 625 pp., illus., diagrs., charts, maps, tables, 8×5 in., cloth, \$3.75.
Intended as a text for students and a reference book for engineers and surveyors, this work covers the topics regularly met in surveying practice and also includes basic information about public land surveying, earthwork, astronomy, hydrographic surveys, etc. Special attention is paid to the sources of error in field operations and their correction. Bibliographies are provided for the more important chapters.

(THE) THEORY OF GROUND-WATER MOTION. By M. K. Hubbert. Journal of Geology, University of Chicago, Chicago, Ill., November-December, 1940, pp. 785–944, diagrs., charts, tables, $9\frac{1}{2} \times 7$ in., paper, \$1.25.
This volume presents a new analytical theory of ground-water flow, which the author feels is more generally applicable and in greater conformity with basic physical principles. The theory is based on Darcy's law for ground-water motion, and particular attention is given to the practical problems of ground-water hydrology.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page to members of the Founder Societies (30 cents to all others), plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

CONCRETE ARCH, DEMOLITION. Brussels Bridge Somersaults, G. D. Clothier. *Roy. Engrs. J.*, vol. 54, Dec. 1940, pp. 521–523. Methods used in demolition of 3-span concrete arch highway bridge, 48 ft wide and 142 ft long, on Rue de Bonne, in Brussels, Belgium, during German invasion of May 1940.

CONCRETE FRAME, ONTARIO. Dual Concrete Bridges. *Roads & Bridges*, vol. 78, no. 12, Dec. 1940, pp. 22–24. Design of dual rigid-frame highway bridge being constructed at Pickering, Ont.; two parallel structures consist of six rigid-frame spans totaling 488 ft.

PONTOON, RAILINGS. Safety, Beauty, and Visibility, L. Lovegren. *Western Construction News*, vol. 16, no. 2, Feb. 1941, pp. 44–46. Railings of Lake Washington concrete pontoon bridge designed to permit good view from passing vehicles and give feeling of security to pedestrians.

PONTOON, SEATTLE, WASH. Machinery for World's Only Floating Draw Span, D. L. Pratt. *Western Machy. & Steel World*, vol. 32, no. 3, Mar. 1941, pp. 110–111. Only floating draw span in world, in Lake Washington concrete pontoon bridge at Seattle, weighs 10,000,000 lb, yet it is opened or closed in $1^1/_2$ min with application of only 150 hp; details of machinery responsible for this operation; electrical power is applied through two Westinghouse type B-1 motors, synchronized as to speed.

RAILROAD, RECONSTRUCTION. Methods of Bridge Replacement on C.N.R. near Aurora Ont. *Roads & Bridges*, vol. 78, no. 12, Dec. 1940, pp. 15–19 and 66. Renewal of grade-separation bridge on Newmarket subdivision of Canadian National Railways near Aurora, Ont., demonstrating suitability of steel H-piles, driven to refusal, as means of overcoming unstable foundation conditions and effectiveness of carefully planned erection methods.

STEEL TRUSS, LUDLOW FERRY, MD. Floating Falsework for Bridge Erection. *Eng. News-Rec.*, vol. 126, no. 9, Feb. 27, 1941, pp. 320–323. Special equipment and methods used in erection of 83 truss and girder spans of Potomac River Bridge at Ludlow Ferry, Md., totaling 10,050 ft in length; balanced cantilever erection; Wichert truss erection.

STEEL, WELDING. Welding for Bridge Repairs, K. B. Wolfskill. *Welding Engr.*, vol. 26, no. 1, Jan. 1941, pp. 22–24. How arc welding and gas cutting were used in reclaiming 810-ft highway bridge; repair details and cost comparisons given.

SUSPENSION, FAILURE. Wind Failures of Suspension Bridges or Evolution and Decay of Stiffening Truss, J. K. Finch. *Eng. News-Rec.*, vol. 126, no. 11, Mar. 13, 1941, pp. 402–407. Study of records revealing numerous accidents similar to failure of Tacoma Narrows suspension bridge, all due to lack of stiffening or rigidity; disasters to flexible British suspension bridges; modern decline of stiffening truss. Bibliography.

WOODEN. Repair and Renewal of Ballasted Deck Bridges. *Can. Transportation*, Jan. 1941, pp. 9–11. Major reference made to treated wood bridges and trestles; inspection of treated ballasted deck trestles; inspection of ballasted decks on steel spans; economic life of trestle; renewing timber decks on steel spans; ballast lift increases dead load. Excerpts from committee report before Am. Ry. Bridge & Bldg. Assn.

BUILDINGS

CONCRETE. Strengthening Frame of 27-Year-Old Concrete Building, C. P. Lewellen. *Eng. News-Rec.*, vol. 126, no. 11, Mar. 13, 1941, pp. 416–419. Methods adopted for increasing load-bearing capacity of 7-story Stark Lyman Building, Cedar Rapids, Iowa, including encasement of columns in concrete and addition of steel beams and columns; shrinkage problems; transfer of column bearing loads; hoops with hooks, nstead of spirals, reinforcing new shells around columns.

CITY AND REGIONAL PLANNING

CITIES AND TOWNS, REHABILITATION. Rehabilitation of Blighted Urban Areas, E. H. Hoben. *Pub. Mgmt.*, vol. 23, no. 2, Feb. 1941, pp. 35–42. Proposals and experiences suggest several methods of rebuilding worn-out areas of cities.

NATIONAL DEFENSE, HOUSING. Local Planning for Defense Housing, C. F. Palmer. *Am. City*, vol. 56, no. 2, Feb. 1941, pp. 37–38. Discussion of policies of Division of Defense Housing Coordination in providing shelters for defense workers wherever defense activity threatens housing shortage; question of future development; slum clearance for defense and permanent improvement. Before Am. Inst. Planners.

CONCRETE

AGGREGATES, STANDARDS. Tough Specifications for Big Aqueduct, J. R. Norton. *Rock Products*, vol. 44, no. 3, Mar. 1941, pp. 30–33. Specifications for processing 800,000 cu yd of concrete aggregates for Delaware Aqueduct, New York City water supply, requiring elimination of crusher grits from sand; use of hydro-separator followed by classifier to recover fines and eliminate silt and micaceous material; crushing, screening, and sand classifying equipment; conveyor system and bin storage arrangements; flow sheet of materials.

CONSTRUCTION, COLD WEATHER. Day's Routine of Placing Concrete During Cold Weather. *Concrete*, vol. 49, no. 1, Jan. 1941, pp. 16 and 25. Working procedure employed in placing viaduct floor for concrete highway bridge in Ohio is given as example.

JOINTS. Concrete Pavement Joints Designed for Load Transfer, J. W. Cushing and W. O. Fremont. *Concrete*, vol. 49, no. 1, Jan. 1941, pp. 5–6. Purpose of paper is that of establishing rational procedure of design of load-transfer joints in concrete pavements; data obtained agree favorably with measurements of variables in actual pavements. Before Highway Research Board, Washington.

PROPERTIES. How Dispersing Agents Improve Properties of Cement and Concrete, E. W. Scripture. *Concrete*, vol. 49, no. 3, Mar. 1941, pp. 5–6. How such properties as durability, watertightness, strength, lessened shrinkage, and lessened permeability in cement and concrete are improved by addition of dispersing agents is explained.

WATER TANKS AND TOWERS. Prestressed Concrete Water Tanks. *Eng. News-Rec.*, vol. 126, no. 11, Mar. 13, 1941, pp. 419–421. Design and construction of 11 new circular prestressed-concrete water tanks, ranging in capacity up to $3^1/_2$ mg, built in recent years by East Bay Municipal Utility District, Oakland, Calif.; details of prestressing wrench used in tightening steel bands; pouring concrete in dome-shaped roof over 1-mg circular tank.

CONSTRUCTION INDUSTRY

GREAT BRITAIN. War-Time Building Construction. *Engineering*, vol. 150, no. 3910, Dec. 20, 1940, p. 495. Review of War-time Building Bulletins Nos. 10 and 11, issued by Department of Scientific and Industrial Research; in Bulletin No. 10, the whole field of war-time building is brought under review; among more important is air raid protection; Bulletin No. 11 deals with precautions which must be taken when carrying out concreting and bricklaying in cold weather; each Bulletin is published at price of 1s.

UNITED STATES. Annual Review Number. Survey of 1940. *Western Construction News*, vol. 16, no. 1, Jan. 1941, pp. 1–28. Survey of the construction industry in the United States for 1940 and prospects for 1941, including following: Army-Navy Programs for 1941, A. Kruckman; Public Roads Administration Program for 1941; Large Contracts Awarded During 1940; Canada to Argentina by Road, A. Diefendorf; Reclamation Program $60,847,000; State Highway Programs for 1941; U.S. Corps of Engineers Plans.

DAMS

CALIFORNIA. New Debris Dams Will Revive California's Hydraulic Gold-Mining Industry. *Min. & Met.*, vol. 22, no. 411, Mar. 1941, pp. 172–173. Note on completion, in January 1941, of 237-ft Upper-Narrows hydraulic debris dam on main Yuba River; project is key unit in series of four similar structures; dam is single-arch type, with debris storage capacity of more than 118,000,000 cu yd; cost was $4,500,000; historical summary of hydraulic mining.

CONCRETE GRAVITY, VIRGINIA. Design and Construction Features of Claytor Hydro Development, P. Sporn and H. A. Kammer. *Eng. News-Rec.*, vol. 126, no. 11, Mar. 13, 1941, pp. 392–397; editorial comment p. 390. Design and construction of concrete-gravity spillway dam, 540 ft long, about 130-ft maximum height, built by American Gas and Electric Company on New River near Radford, Va., featuring elaborate grouting and foundation consolidation and asphalt cutoff; geology of site; concreting procedure; joints in concrete; provision for flood flows.

CONSTRUCTION, EGYPT. Mohammed Aly Barrages, Egypt, A. G. Vaughan-Lee. *Instn. Civ. Engrs.—J.*, vol. 15, no. 4, Feb. 1941, pp. 237–267 (discussion) 268–279, supp. plates. Materials, equipment, and methods used in construction of new Damietta and Rosetta barrages and locks in Nile River delta; structures, respectively, 406 m and 533 m long; construction of regulators, bridges, and other appurtenant works.

EARTH, CALIFORNIA. Prado Dam Project Completed, I. C. Hoffman. *Western Construction News*, vol. 16, no. 2, Feb. 1941, pp. 48–51. Report on construction of Prado earth-fill dam near Corona, Calif., having maximum height of 110 ft, crest length of 2,280 ft, bottom width of over 800 ft, and crest width of 30 ft; embankment construction; excavation for cutoff wall; concrete placing; major units of equipment.

EARTH, CONSTRUCTION. Farm Earth Moving as Applied to Pond Building, W. A. Harper. *Agric. Eng.*, vol. 22, no. 1, Jan. 1941, pp. 19–24. Discussion of methods and equipment for construction of small dams for ponds for water supply and irrigation of farms; comparison of various types of equipment used for building small earth dams; capacities of various types of equipment used for building farm ponds or small earth dams. Before Am. Soc. Agric. Engrs. Bibliography.

EARTH, DESIGN. Innenkern oder wasserseitige Dichtung bei Daemmen? J. Stiny. *Bautechnik*, vol. 18, no. 47/48, Nov. 1, 1940, pp. 541–543. Comparative discussion of impervious central cores versus impervious decks at upstream face of earth dam embankments.

EARTH, WASHINGTON. Mud Mountain Dam Will Be Covered with 328-Ft Tent. *Western Construction News*, vol. 16, no. 2, Feb. 1941, p. 56. Fabrication of 328-ft by 196-ft tent which will be hung over earth core of Mud Mountain Dam during embankment construction to maintain constant moisture content.

HYDRAULIC FILL, MONTANA. Investigation and Reconstruction of Fort Peck Dam Slide, J. S. Leland. *Military Engr.*, vol. 33, no. 187, Jan.-Feb. 1941, pp. 26–31. Report on partial failure and subsequent reconstruction of Fort Peck hydraulic-fill dam in Montana; details of explorations and salvage operations; reconstruction measures; proposed changes for intake structures.

HYDRAULIC GATES. Eleven Drum Gates to Control 1,000,000 Sec/Ft Flow over Grand Coulee Spillway. *Eng. News-Rec.* (News Issue), Feb. 6, 1941, pp. 198–199. Principal features of eleven, 135 by 28-ft drum gates providing movable spillway crest 1,485 ft long which, when fully lowered, with reservoir level 30 ft above

minimum crest elevation, have outlet of capacity 1,000,000 cu ft per sec.

RESERVOIRS, OUTLETS. Plant for Denison Dam Outlet Works, E. G. Wernentin. *Eng. News-Rec.*, vol. 126, no. 9, Feb. 27, 1941, pp. 327–329. Description of plant for construction of penstocks and other outlet works at Denison Dam, on Red River between Oklahoma and Texas, covering area 256 ft wide and 1,632 ft long, including 1,660-ft traveling cableway, served by shuttle trains loaded at central plant and operating over trestle.

FLOOD CONTROL

FLOODS, FORECASTING. Flood-Forecasting Service in Pennsylvania, J. W. Mangan. *Am. Water Works Assn.—J.*, vol. 33, no. 2, Feb. 1941, pp. 213–218. Early forecasting techniques; forecasting survey in Pennsylvania; adoption of unit-hydrograph method for use in flood forecasting in Pennsylvania; organization of forecasting service; facilities for communication.

WATERSHEDS, PROTECTION. Crops and Dams Protect Watershed, E. Wolfe. *Agric. Eng.*, vol. 22, no. 2, Feb. 1941, pp. 62–64. Discussion of soil-saving crops and detention dams as defense against floods and erosion in McGregor watershed, bordering Mississippi River, in northeastern Iowa; specifications for dams and reservoirs; future protection of watershed. Before Am. Soc. Agric. Engrs.

FOUNDATIONS

BUILDINGS. Foundations for Basement Buildings Adjoining Existing Property, S. K. Jordan. *Instn. Civ. Engrs.—J.*, vol. 15, no. 2, Dec. 1940, pp. 119–140. Problems associated with foundations of buildings in congested areas; shoring; foundations; underpinning; retaining walls; basement tanks; lead seal.

COFFERDAMS, DESIGN. Bodenmechanische Gesichtspunkte fuer die Berechnung von Fangedaemmen, O. K. Froehlich. *Bautechnik*, vol. 18, no. 47/48, Nov. 1, 1940, pp. 543–547. Mathematical discussion of application of principles of modern soil mechanics to design and construction of cofferdams; numerical examples.

DAMS. Geological and Geophysical Surveys, Cobb Valley, Nelson, H. W. Wellman. *New Zealand J. Science & Technology*, vol. 22, no. 1B, July 1940, pp. 52B–61B. Results of geological, magnetic, and seismic observations of section of Cobb Valley, western Nelson, N.Z., where dam is to be erected as part of hydroelectrical power scheme.

DESIGN. Neue Richtlinien fuer die zulaessige Belastung des Baugrundes und der Pfahlgruendungen, Wedler. *Zentralblatt der Bauverwaltung*, vol. 60, no. 40, Oct. 2, 1940, pp. 655–660. Discussion of new data and methods for determination of permissible loads on foundation sites and on pile foundations.

PILE. Die Berechnung Besonderer Raeumlicher Pfahlroste, H. Bay. *Bauingenieur*, vol. 21, no. 45/46, Dec. 5, 1940, pp. 352–353. Theoretical mathematical discussion of design of pile foundations consisting of groups of batter piles driven with various inclinations in four different directions.

PORT STRUCTURES, MOBILE, ALA. Port Structures Provide for Settlement, H. E. Myers. *Eng. News-Rec.*, vol. 126, no. 9, Feb. 27, 1941, pp. 336–338. Construction, at Mobile, Ala., of additional ship berths and transit sheds, which were recently completed under PWA loan and grant of $760,000, including apron wharf 1,225 ft long, and tracks, roads, and other appurtenances; economy obtained by developing design that permits settlement of fill under long transit shed without injury to wharf or shed itself; driving batter piles for new wharf; superstructure of transit shed.

RETAINING WALLS, DESIGN. Construction Design Chart—LXII . . . Cantilever Retaining Walls, J. R. Griffith. *Western Construction News*, vol. 16, no. 2, Feb. 1941, p. 57. Alinement for computing wall thickness and reinforcement of concrete cantilever retaining walls, up to 30 ft in height; numerical examples.

SOILS, TESTING. Some Important Considerations in Design and Use of Soil Pressure Cells, A. C. Benkelman and R. J. Lancaster. *Pub. Roads*, vol. 21, no. 12, Feb. 1941, pp. 235–243. Report on experimental study of pressure measurement in soils and its application to design of non-rigid road surfaces; tests of pneumatic pressure cells, demonstrating that if pressure cell is rigid and soil is compressible, accuracy of pressure indication will depend on cell dimensions and relation between pressure-sensitive area and total facial area exposed to pressure.

HYDRAULIC ENGINEERING

HYDRAULIC LABORATORIES, MINNEAPOLIS, MINN. St. Anthony Falls Hydraulic Laboratory, L. G. Straub. *Nat. Engr.*, vol. 45, no. 2, Feb. 1941, pp. 96–100. Hydraulic research laboratory for University of Minnesota designed to operate by diversion of water from Mississippi River above St. Anthony Falls, through laboratory and subsequently back to river below falls; hydraulic machinery, pump, and turbine-testing laboratory described along with general information on laboratory building and courses of study.

HYDROELECTRIC POWER PLANTS

OKLAHOMA. Pensacola Dam Completed, H. D. Robards. *Power Plant Eng.*, vol. 45, no. 2, Feb. 1941, pp. 72–73 and 93. Description of 80,000-hp power development on Grand River in northeast Oklahoma, known as Pensacola Project; details of combination hydroelectric flood-control dam which is longest known multiple-arch dam; powerhouse and equipment details given.

SOUTH CAROLINA. Santee-Cooper Development, K. H. Talbot. *Military Engr.*, vol. 33, no. 187, Jan.-Feb. 1941, pp. 10–11. Outline of improvement program for Santee and Cooper rivers in South Carolina, including construction of: 216,000-hp hydroelectric power plant; highest single-lift lock in United States (75-ft lift, 60 ft wide, 180 ft long); 30 miles of earth dikes and 10 miles of earth dam; concrete spillway having length of 3,200 ft for passing 800,000 cu ft per sec; 5-mile pulp fill across floodway of Santee River; excavation of 7 miles of diversion canal, etc.

HYDROLOGY AND METEOROLOGY

SOILS, EROSION. Application of Erosion Equation to Strip Crop Planning, R. W. Gerdel and R. E. Allen. *Agric. Eng.*, vol. 22, no. 2, Feb. 1941, pp. 59–61 and 64. Strip cropping as soil conserving practice; field studies of relationship between soil loss and such factors as land slope, watershed length, divergence from contour, soil type, land use on contributing watershed, and degree of previous erosion; Zingg erosion equation; comparison of measured soil loss with loss calculated by erosion equation. Bibliography. Before Am. Soc. Agric. Engrs.

INLAND WATERWAYS

HYDRAULIC GATES. 28-Foot Valves Control a River. *Universal Engr.*, vol. 72, no. 2, Aug. 1940, pp. 30–33. Valves 28 ft in diameter installed at Fort Peck Dam, Montana, to control Missouri River; six main valves are located in four shafts each 200 ft deep; four tunnels, each 600 ft long and 25 ft 8 in. in diameter, will carry water from reservoir to main control shafts; essentially, main valve assembly consists of two major sections, casing or port liner, and gate, or plug, which is raised or dropped inside port liner to open and close valve; construction and operation of valves.

IRRIGATION

CANALS, DESIGN. Regime Flow in Incoherent Alluvium, G. Lacey. *India Central Board Irrigation—Publ. No. 20*, July 18, 1939, 65 pp., supp. plates. Design of stabilized silt carrying irrigation canals based on balance between silting and scouring and dynamic equilibrium in forces generating and maintaining channel cross section and gradient; Kennedy and Lindley theories; correlation of hydraulic mean depth with mean velocity and slope; regime equation; derivation of new flow equation; new theory correlating turbulence, bed silt grade, and shock; correlation of silt factor and bed silt grade in coarse material.

OVERHEAD. Uniformity of Application of Water by Sprinkler Systems. J. E. Christiansen. *Agric. Eng.*, vol. 22, no. 3, Mar. 1941, pp. 89–92. Results of numerous field tests of effect of spacing, arrangement, and operation of irrigation sprinklers on uniform distribution of water over surface of soil in such manner that there can be absorption without runoff; uniformity coefficients for actual sprinkler patterns with various spacings of sprinklers. Before Am. Soc. Agric. Engrs.

LAND RECLAMATION AND DRAINAGE

SHORE PROTECTION, FLORIDA. Bulkheading Expands Miami's Shore, W. Warburton. *Earth Mover*, vol. 27, no. 12, Dec. 1940, pp. 5–8. Construction of bulkhead, faced with concrete slabs, for protection of reclaimed shore area 7,050 ft by 1,560 ft at Miami, Fla.

MATERIALS TESTING

CONCRETE. Research Sets Proportions for Concrete in Advance, W. A. Blanchette. *Concrete*, vol. 49, nos. 2 and 3, Feb. 1941, pp. 8–11 and 54, and Mar., pp. 33–35. Article describes method that may be adapted for use in research investigations pertaining to concrete and to materials of which concrete is composed; mechanical equipment employed in laboratory investigation; test procedure; manner of applying data obtained to practical problem of determining correct proportions for desired quality of concrete.

MUNICIPAL ENGINEERING

EXPRESSWAYS, CHARLESTON, W. VA. Riverfront Boulevard for Charleston, C. P. Fortney. *Eng. News-Rec.*, vol. 126, no. 11, Mar. 13, 1941, pp. 414–416. Design and construction of 5-mile six-lane expressway on bank of Kanawaha River at Charleston, W. Va., including 250-ft girder span and municipal parking lot; details of concrete safety curbs; river bank protection.

PORTS AND MARITIME STRUCTURES

CLEVELAND, OHIO. Cleveland Modernizes Its Harbor, G. B. Sowers. *World Ports*, vol. 3, no. 5, Feb. 1941, pp. 6–10 and 27. Historical review; Cuyahoga River improvement nears completion; recent bridge improvements; channel improvements; acquiring land; construction costs; future work planned; commerce of port.

DALLES, ORE. Port of Dalles, Oregon, U.S.A. *Dock & Harbour Authority*, vol. 21, no. 241, Nov. 1940, pp. 3–6. Report on recent developments of Columbia River port of The Dalles, Ore.; description of port; general facilities and equipment; construction features.

DISINTEGRATION. Extermination Tests on Marine Borers, T. H. Hansen. *World Ports*, vol. 3, no. 5, Feb. 1941, pp. 11–13. Stopping marine-borer attack on chemically treated piles; to gather information concerning efficacy of Toxic Refill Method, 15 piles selected at random were given accelerated test for purpose of determining how long it takes to exterminate borers living within piles; treatments were increased, and periodical inspections of specific areas of piles were made at one- to three-month intervals; results given.

TOKYO, JAPAN. Port of Tokyo, S. Kitamura. *Dock & Harbour Authority*, vol. 21, no. 242, Dec. 1940, pp. 25–28. History and development of port of Tokyo; improvement of entrance channel; present condition of maritime installations; imports and exports; projected improvement work of Tokyo harbor.

ROADS AND STREETS

AIRPORT RUNWAYS. Highway Practices as Applied to Airports, R. W. Crum. *Roads & Bridges*, vol. 79, no. 2, Feb. 1941, pp. 21–22, 94, and 98. Principles of design and construction of runway foundations and surfaces; design formulas; runway maintenance. Before Nat. Asphalt Conference.

AIRPORT RUNWAYS. Record Runway Paving Speed. *Western Construction News*, vol. 16, no. 2, Feb. 1941, p. 47. Report on design and rapid construction of second concrete-paved runway at Lowry Field airport near Denver, Colo., having width of 150 ft and length of 5,000 ft.

ALBERTA. Engineering and Construction Problems on Banff-Jasper Highway, T. S. Mills. *Roads & Bridges*, vol. 79, no. 2, Feb. 1941, pp. 16–18 and 74. Construction of 140 miles of mountain highway between Lake Louise and Jasper, Alberta, 60 miles of which is over one mile above sea level; mechanization of construction operations; features of culverts built of native logs; features of highway bridges.

BRICK. Brick Surface on Concrete Base for Detroit Street Widening, W. H. Harvie. *Construction Methods*, vol. 23, no. 2, Feb. 1941, pp. 50–51, 54, 93–94, and 96–97. Methods and equipment used in reconstruction of brick concrete base section, 0.9 mile long, of Michigan Avenue, Detroit, Mich.; preliminary work; track encasement; brick surface construction; joint filler; special provisions.

BRICK. Modern Brick Pavements Developed by Experience and Research, W. H. Cullimore. *Roads & Streets*, vol. 84, no. 1, Jan. 1941, pp. 45–49. Review of research work in progress on various construction types of brick pavements, including two-course pavements, vibrated monolithic pavements, and reinforced brick pavements.

CONSTRUCTION. Constructing Runways and Highways from Shifting Sands, G. E. Martin. *Pub. Works*, vol. 71, no. 12, Dec. 1940, pp. 22–23. Data on grades and proportions of tar used as binder for sand for airport runways as well as for roads on Cape Cod, Massachusetts, and along entire Atlantic coast from Delaware to Florida.

CONSTRUCTION. Dredged Fill from Columbia River Carries Parkway Through Gorge, R. H. Baldock. *Construction Methods*, vol. 23, no. 1, Jan. 1941, pp. 54–55, 98, 100, and 103. Description of methods and equipment used in construction of 18-mile section of new Columbia River highway, in Oregon, by stepping out into river and building in water, 30 to 60 ft deep; hydraulic fill of material dredged from streambed and retained by rock toe wall to prevent erosion.

CONSTRUCTION. Indiana Salvages Old Slab for U.S. 20 Widening. *Construction Methods*, vol. 23, no. 1, Jan. 1941, pp. 56–58, 80, 82, 84, and 86. Economic design and construction of widened 12-mile stretch of U.S. 20 near Michigan City, Ind., by salvaging old 18-ft concrete slab wherever possible, and using it as part of base under asphalt surface of inner lanes; curb construction; paving operations; asphaltic surface; grade separations.

CONSTRUCTION. New King George VI Highway. *Eng. & Contract. Rec.*, vol. 54, no. 2, Jan. 8, 1941, pp. 17–19, and 26. Construction of new King George VI highway, 14 miles long, connecting Trans-Canada Highway near New Westminster, B.C., with Blane, Wash.; typical cross sections; features of new type of highway bridges.

HIGHWAY ENGINEERING, STANDARDS. California Revises Its Standard Specifications for Highway and Bridge Work. *Western Construction News*, vol. 16, no. 2, Feb. 1941, pp. 41–43. Study of changes made in recently revised standard specifications of California Division of Highways, with special reference to control of materials, legal relations and responsibility, prosecution and progress, measurement and payment, and construction details.

HIGHWAY SYSTEMS, MANITOBA. Trans-Canada Highway in Manitoba, G. B. Williams. *Eng. & Contract. Rec.*, vol. 54, no. 2, Jan. 8, 1941, pp-

8–11 and 16. Methods and equipment used in construction of 37-mile section of Trans-Canada Highway in Manitoba running from Portage la Prairie to Sidney; details of base course and bituminous surfaces; cost data.

HIGHWAY SYSTEMS, NATIONAL DEFENSE. Adapting Washington State Highways to National Defense Needs, J. A. Davis. *Construction Methods*, vol. 23, no. 1, Jan. 1941, pp. 48–49, 103–104, 106, and 108. Improvements projected and being carried out in state of Washington highways to bring them up to modern military standards; national defense access roads.

HIGHWAY SYSTEMS, NATIONAL DEFENSE. Michigan Builds First Military Highway, G. D. Kennedy. *Construction Methods*, vol. 23, no. 1, Jan. 1941, pp. 39, 96, and 98. Description of first national defense highway in United States, recently completed at Fort Custer, Mich., having four-lane divided concrete pavement, 2.337 miles long, with 4-ft wide bituminous-surfaced dividing strip.

HIGHWAY SYSTEMS, NATIONAL DEFENSE. Military Access Roads to Army Camps, Naval Bases and Industrial Plants Are Nation's No. 1 Defense Highway Problem. *Construction Methods*, vol. 23, no. 1, Jan. 1941, pp. 42–44, 74, 76, and 78. Survey of access-road requirements for military, naval, and industrial establishments in United States, showing needed total of 2,900 miles, costing $194,000,000; typical demands for new roads; improvements needed to satisfy modern standards.

HIGHWAY SYSTEMS, NATIONAL DEFENSE. Our Highways and National Defense, T. H. MacDonald. *Pit & Quarry*, vol. 33, no. 7, Jan. 1941, pp. 86–87. In field of traffic routes as distinguished from access roads, War Department has certified system of roads called strategic network, consisting of about 75,000 miles; classification of all defense highways, as adopted; review of background of existing major highways; factors that concern immediate program. Abstract from address before Nat. Asphalt Conference, Dec. 10, 1940.

HIGHWAY SYSTEMS, PAN-AMERICAN. Canada to Argentina by Road, A. Diefendorf. *Western Construction News*, vol. 16, no. 1, Jan. 1941, pp. 11–13. Review of development and present status of construction of Pan-American highway system from Fairbanks, Alaska, to beyond Buenos Aires, Argentine.

HIGHWAY SYSTEMS, PENNSYLVANIA. Expediting Construction on Pennsylvania Turnpike, H. H. Miller. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 349–360. Methods developed by engineers of Pennsylvania Turnpike Commission for placing more than four million square yards of 9-in. uniform reinforced concrete pavement in two and one-half months; material requirements; transportation; paving schedules; typical paving contracts.

MAINTENANCE AND REPAIR. Highway Maintenance Equipment. *Eng. News-Rec.*, vol. 126, no. 9, Feb. 27, 1941, pp. 346–347. Organization of Central Control Bureau of Department of Highways of Virginia, handling equipment necessary for maintenance, and minor construction done by its own forces; inter-departmental rental rates for highway equipment; cost of operations.

MICHIGAN. Michigan Builds Camp-Access Road. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 88–90. Design and construction of 3-mile four-lane highway into heart of Fort Custer army cantonment, west of Battle Creek, Mich., providing access to new camp by making connection with existing roads.

NATIONAL DEFENSE, HIGHWAY SYSTEMS. Defense Roads in 1941 Program. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 83–87. Discussion of general routes selected by U.S. War Department for system of highways needed for national defense; access roads to camps; WPA road work; access to war industries; by-passes and superhighways; city access roads; bridge construction; Alaska highway; prospect for 1941.

NATIONAL DEFENSE, HIGHWAY SYSTEMS. Roads in Maneuver Areas. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 91–94. Performance of main and secondary roads in Texas, New York, Wisconsin, and Louisiana during army maneuver traffic in summer of 1940; types of damage to gravel-surfaced road.

NEW HAMPSHIRE. New Highway on Old Railway, G. H. Tuttle. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, p. 755. Utilization of right of way of 9-mile narrow-gage branch from Boston and Maine Railroad to Profile House near Echo Lake, New Hampshire, to replace section of Daniel Webster Highway, which has many sharp curves and grades.

ONTARIO. Scenic Highway in Northern Ontario, T. F. Francis. *Roads & Bridges*, vol. 79, no. 2, Feb. 1941, pp. 11–13 and 112. Construction of 50-mile section of Trans-Canada highway between Nipigon and Geraldton, Ont., including heavy rock cuts; description of highway.

RAILROAD CROSSINGS, CONSTRUCTION. Railroad Girder Spans Jacked Into Place, J. R. Carr. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 172–174. Construction of two deck-girder spans for underpass on relocation of U.S. Highway 30, west of Cheyenne, Wyo., built on falsework alongside tracks and jacked into place between passage of trains; falsework and jacking arrangements.

RAILROAD CROSSINGS, ELIMINATION. Grading Troubles Featured This Crossing Elimination Job. *Ry. Age*, vol. 110, no. 6, Feb. 8, 1941, pp. 280–284. Unstable slopes and soft roadbed were among difficulties encountered in long cuts on Great Kills-Huguenot project on Staten Island Rapid Transit Lines of B. & O. as described in article.

ROAD MATERIALS, GERMANY. Materials and Machinery Used in Construction of State Motor Roads and Highways in Germany, E. W. Goerner. *Eng. Progress*, vol. 21, no. 6, Oct. 1940, pp. 93–100. Detailed account of preparation and application of materials for highway construction discussing cement, bitumen, tar, natural stone, earthwork, concrete structures, and machinery in construction of German state motor roads.

SNOW REMOVAL. Snow Removal from Streets of Canada's Metropolis, J. E. Blanchard. *Eng. & Contract. Rec.*, vol. 53, no. 44, Oct. 30, 1940, pp. 15–18. Organization for snow removal in Montreal; illustrated description of snow conditions and equipment that each condition commands.

SNOW REMOVAL. Yearly Battle with Snow on Roads Near Lake Huron, T. R. Patterson. *Eng. & Contract. Rec.*, vol. 53, no. 48, Nov. 27, 1940, pp. 11–13. Increasing demand for winter use of roads has been responsible for County of Huron keeping open about 396 miles of road during winter months; notes on snow-removal equipment and snow-clearing costs.

STABILIZATION. Laboratory Research on Stabilized Soil as Base Course, J. B. Garneau. *Eng. & Contract. Rec.*, vol. 54, no. 2, Jan. 8, 1941, pp. 20–23. Report on Canadian laboratory studies of effect of grading and of adding to soil aggregate various materials such as liquid asphalt, emulsion, coal tar, portland cement, gypsum, sodium and calcium chlorides, and waste sulfite liquors.

STABILIZATION. Stabilized Gravel Over Bituminous Mulch, D. J. Emery. *Roads & Bridges*, vol. 78, no. 12, Dec. 1940, pp. 20, 62, and 64. Description of unique road construction in county of Waterloo, Ont., involving use of stabilized gravel over pavement; tests on Waterloo County road; application of stabilized gravel; calculation of thickness; cost of stabilizing.

SUBSOILS. Place of Soil Science in Modern Highway Construction, N. W. McLeod. *Roads & Bridges*, vol. 78, no. 12, Dec. 1940, pp. 25–28, 68–72, and 74–75. Discussion of place of soil science in various phases of modern highway construction; soil classification; principles of drainage; principles of subgrade construction; fundamentals of base course construction; importance of adequate laboratory inspection and control; wearing surfaces. (To be continued.)

SUBSOILS. Place of Soil Science in Modern Highway Construction, N. W. McLeod. *Roads & Bridges*, vol. 79, no. 1, Jan. 1941, pp. 26–29, 70–78 and 80–82. Fundamentals of base course construction; types of soil stabilization; fundamental data for stabilized base course design; effect of moisture on bearing capacity of stabilized mixtures; waterproofed mechanical stabilization; influence of gradation on compressive strength; influence of density on bearing capacity; cost of waterproofed stabilized base courses. (To be concluded.)

SUBSOILS. Place of Soil Science in Modern Highway Construction, N. W. McLeod. *Roads & Bridges*, vol. 79, no. 2, Feb. 1941, pp. 62, 64, 66, 68, and 70. Importance of adequate laboratory inspection and control; cost of inspection; specification for inspection; wearing surfaces; subgrade design and construction; waterproofed mechanical stabilization; comments on highway construction research.

SUBSOILS. Soil Displacement Under Loaded Circular Area, L. A. Palmer and E. S. Barber. *Pub. Roads*, vol. 21, no. 10, Dec. 1940, pp. 183–186 and 198. Outline of procedure for evaluating supporting characteristics of subgrade under flexible types of pavement, using laboratory determined stress-deformation curves for subgrade soil in conjunction with rational theoretical analyses; example illustrating use of principles.

TROPICS. Difficult Problems Encountered in Building Oil-Field Roads, E. H. Austin. *Oil & Gas J.*, vol. 39, no. 33, Dec. 26, 1940, pp. 133, 135–136, and 138. Description of road-building methods of Tropical Oil Co., operating on De Mares concession in Magdalena Valley in Colombia; abundant rainfall, torrid climate, and dense jungle vegetation are troublesome factors; right of way cleared by hand; construction equipment.

SANITARY ENGINEERING

CAMPS, MILITARY. Camp Water Supply and Sewage Disposal. *Eng.-News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 769–770. Design and construction of water supply and sewage disposal systems of 1,000-gpm capacity for Camp Ord military reservation near Monterey, Calif.; asbestos-cement pipe used; filter bed construction.

NOVA SCOTIA. Sanitary Engineering in Nova Scotia, R. D. McKay. *Eng. & Contract. Rec.*, vol. 53, no. 52, Dec. 25, 1940, pp. 41 and 56. Review of recent progress in water purification and sewage disposal in Nova Scotia; improvements in water treatment and sewage disposal plants.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Activated Sludge Bulking, H. Heukelekian. *Sewage Works J.*, vol. 13, no. 1, Jan. 1941, pp. 39–42. Review of fundamental facts regarding activated sludge process for clearer understanding of bulking problem; methods of checking bulking of activated sludge.

DEVELOPMENTS IN 1940. Developments in Sewage Treatment—1940, W. Rudolfs. *Sewage Works Eng. & Mun. Sanitation*, vol. 12, no. 2, Feb. 1941, pp. 65–71. Discussion of development and progress in field of sewage and waste treatment during 1940; New York's major problem; screenings and grit chemicals for sludge dewatering; chemical treatment of sewage; trickling filter results at Baltimore; sewage-garbage treatment; sludge treatment and disposal; gas collection and utilization; sewage chlorination.

DISPOSAL PLANTS, ALBUQUERQUE, NEW MEX. Modern Treatment for Old City, H. C. Neuffer. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 8, Aug. 1940, pp. 364–366 and 368. Description of new 5-mgd sewage disposal plant of Albuquerque, N.Mex., featuring chemical treatment, trickling filters, digestion and gas power production; pumping, flocculation, and clarification; sludge digestion; cooling system.

DISPOSAL PLANTS, DES MOINES, IOWA. Large Trickling Filter Plant with Sludge Digestion. *Am. City*, vol. 55, no. 12, Dec. 1940, pp. 42–44 and 79. Description of new 40-mgd sewage disposal plant of Des Moines, Iowa; features of pump house, trickling filters and tanks; grease removal; primary treatment; sludge digestion.

DISPOSAL PLANTS, DOVER, DEL. Sewage Treatment Housed with Refuse Disposal, T. R. Kendall. *Am. City*, vol. 56, no. 2, Feb. 1941, pp. 44–46 and 79. Description of combined sewage treatment and refuse incineration plant at Dover, Del., serving population of 5,500; screening and pumping; sludge digestion and drying; refuse collection; incineration.

DISPOSAL PLANTS, OPERATION. Sewage Flows and Composition Affecting Treatment, A. M. Rawn. *Sewage Works J.*, vol. 13, no. 1, Jan. 1941, pp. 66–72. Paper before 1940 annual convention of Sewage Works Federation discussing factors affecting operation of sewage disposal plants; conditions of flow; variation in suspended solids load in influent to plain subsidence tanks; efficiency of subsidence; use of filtration through sand or iron grains; use of chlorine as disinfectant; cannery wastes.

DISPOSAL PLANTS, SOUTH AFRICA. Improvements Introduced Into Reconstruction of Klipspruit Sewage Disposal Works, E. J. Hamlin. *South African Instn. Engrs.—J.*, vol. 39, no. 4, Nov. 1940, pp. 78–82, (discussion) 82–83, supp. plates. Features of reconstructed Klipspruit sewage disposal plant at Johannesburg, South Africa, serving population of 300,000 and treating what is reputed to be "strongest" sewage in world; gas recovery; production of purified effluent to be used by proposed new municipal power station; production of effluent fit to be used for irrigation.

DISPOSAL PLANTS, WASTE UTILIZATION. Sludge for City Parks, R. Moses. *Am. City*, vol. 56, no. 2, Feb. 1941, pp. 59 and 61. Plan suggested by Commissioner of Department of Parks in New York City for utilization of sewage sludge for fertilization of New York City parks; disposal of raw sludge; use of digested sludge; use of screenings.

FILTERS, TRICKLING. Role of Trickling Filter in Sewage Purification, M. Levine. *Sewage Works J.*, vol. 12, no. 6, Nov. 1940, pp. 1062–1078. Review of experiments during 1925–1935 which led to introduction of double filtration plants for treating packing house wastes at Mason City and Storm Lake, Iowa, and West Fargo, N.Dak.; data on performance of full-sized plants designed on basis of these laboratory studies; bottom ventilation; dosing cycle; biological and physico-chemical properties of trickling filters. Bibliography. Before Sewage Works Federation.

GAS RECOVERY. Sludge Gas Utilization, R. E. Fuhrman. *Sewage Works J.*, vol. 12, no. 6, Nov. 1940, pp. 1087–1097. Review of uses of sludge gas as they have developed during recent years; use for plant light, heat, and laboratory; use for motor vehicle fuel; use for incineration; power from gas engines; table of sludge gas engine installations in United States; distribution of uses of engines listed in table; heating sludge digestion tanks; hazards in sludge gas handling. Bibliography. Before Sewage Works Federation.

GAS RECOVERY. Using Sludge Gas. *Am. City*, vol. 55, no. 12, Dec. 1940, pp. 63, 65, and 81. Description of new Grass Island sewage disposal plant of Greenwich, Conn., featuring boiler with modulated controls to supplement sludge gas with city gas to maintain proper temperature of water

in digester coils and for heating building in winter; sewage treatment processes, including chlorination.

PLANTS, EQUIPMENT. Mechanical Equipment in Sewage Treatment, L. M. Johnson. *Sewage Works J.*, vol. 13, no. 1, Jan. 1941, pp. 73–85, (discussion) 86–88. Paper before 1940 annual convention of Sewage Works Federation discussing use of mechanical and labor saving equipment in sewage treatment, with particular reference to sewage disposal plants of Sanitary District of Chicago; maintenance of screens, settling tanks, pumps, aeration equipment, and appurtenances; sludge handling.

SELF-PURIFICATION. Self-Purification of Sewage, H. Heukelekian. *Sewage Works J.*, vol. 13, no. 1, Jan. 1941, pp. 61–65. Results of laboratory studies of self-purification of stored sewage brought about by physical, chemical, and biological agencies entailing sedimentation, oxidation, and reduction processes; B.O.D. values of sewage stored under quiescent conditions in deep and shallow layers. Bibliography.

SEWAGE PUMPS. Pumps in Sewage Treatment Plants. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 12, Dec. 1940, pp. 612–613. Discussion by sewage works superintendents of types of pumps used for handling raw sewage, raw sludge, digested sludge, and activated sludge; correction of operating troubles such as dragging, failure to prime, wear, valves, etc.

SEWAGE TANKS. Settling Tank Performance. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 8, Aug. 1940, pp. 385–386. Practical discussion by sewage plant superintendents on period of detention in primary and final settling tanks, inlet and outlet systems, efficiency of solids removal, grease and scum removal.

SEWERS, CAST IRON. 3,000 Tons of Cast Iron Pipe Being Used for Sewer Construction in Chicago Subway. *Cast Iron Pipe News*, vol. 7, no. 1, Jan. 1941, pp. 6–11. Cast-iron pipe sewers throughout project range in size from 4 to 6 in. in diameter and serve three duties: (1) collect seepage and general drainage from track level 48 ft below city streets, (2) handle sanitary sewerage from station, and (3) replace and relocate city sewers already in street to make room for subway structures.

SEWERS, CONSTRUCTION. Exacting Conditions Govern Rock Tunnel Driving for Washington, D.C., Sewers. *Construction Methods*, vol. 22, no. 12, Dec. 1940, pp. 54–56, 87–88, and 90–92, and 94. Special equipment and methods used in construction of 11,000 lin ft of sewer tunnels in rock formation at Washington, D.C.; blasting procedure; crossing of water tunnel; drilling and mucking; open-cut construction.

SLUDGE. Flash Drying of Sludge. *Chem. & Met. Eng.*, vol. 48, no. 1, Jan. 1941, pp. 108–111. Flow sheet giving procedure followed in Southwest Works, Chicago, in handling large quantities of industrial and domestic waste matter in such a way as to effect complete disposal without nuisance; fundamental principle is drying material in very small particles in medium having high specific heat; capacity of works is 400,000,000 gal.

SLUDGE. Progress in Conditioning of Sewage Sludge for Dewatering, F. W. Jones. *Sewage Works J.*, vol. 12, no. 6, Nov. 1940, pp. 1106–1115. Review of experiences in dewatering of sewage sludge, with particular emphasis on preparation for effective dewatering by mechanical means; types of sewage sludge; early and present-day methods of dewatering; conditioning for vacuum filtration; results obtained; future work; appendix on manufacture of chlorinated copperas at Baltimore sewage works, by C. E. Keefer; cost of making chlorinated copperas. Bibliography. Before Sewage Works Federation.

UNITED STATES. Developments and Trends in Sewerage Practices, A. Wolman and A. H. Fletcher. *Water Works & Sewerage*, vol. 88, no. 2, Feb. 1941, pp. 45–59. Review of 1940 progress in sewage treatment in United States, with particular emphasis on treatment of industrial wastes, chemical precipitation, grease and scum removal, trickling filters, activated sludge, chlorination of sewage, sludge concentration, dewatering and incineration, sludge gas utilization; sewage sludge as fertilizer; financing; research; trends in legislation; defense problems.

STRUCTURAL ENGINEERING

BEAMS, BOX. Pre-Cast Box Beams for High Strength, H. M. Hadley. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 838–839. Results of tests of pre-cast cellular concrete beam 36 in., by 16½ in., by 19.75 ft in length; bundle bars used for main reinforcement; punching shear test.

FRAMED STRUCTURES, DESIGN. Moments in Frames Without Side Sway, E. Shepley. *Concrete & Constr. Eng.*, vol. 35, no. 10, Oct. 1940, pp. 493–505. Theoretical mathematical discussion of incomplete fixity produced by rigidity of one or more members in framed structure which meet at, and are continuous with, end of beam; at junction of beam and external column in reinforced concrete frame building; moment distribution; effect on columns; examples of frame analysis.

HOUSES, LOW COST. Flat Plate Rigid Frame Design of Low Cost Housing Projects in Newark and Atlantic City, N.J. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 309–324. Description of six low-cost housing developments in Newark, N.J., and of one in Atlantic City, N.J.; economies in cost and speed of erection effected by use of novel type flat-plate rigid-frame design; discussion of basis of design; construction methods; and comparative costs.

TOWERS, EARTHQUAKE RESISTANCE. Earthquakes Influence Tower Design. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 812–814. Design and construction of 16-story 279-ft tower of Hoover Library at Stanford University, Calif.; steel frame is designed to carry wind loads and reinforced concrete outer walls to carry earthquake loads; at second-floor level, shears from tower are distributed over base five and a half times tower area; details of welded connections for diagonals; fenestration.

TRUSSES, CONTINUOUS. Moment Distribution and Analysis of Continuous Truss of Varying Depth, E. R. Jacobsen. *Eng. J.*, vol. 23, no. 12, Dec. 1940, pp. 502–508. Mathematical analysis of five-span continuous highway truss of varying depth by adapting moment-distribution method, without reference to areas of members; way of making one set of moment distributions cover all cases of partial loadings; technique for finding fixed-end moments and carry-over and stiffness factors for varying depth truss. Bibliography. Before Eng. Inst. Canada.

WALLS, BRICK. Brick Cavity Walls. *Arch. Forum*, vol. 73, no. 6, Dec. 1940, pp. 527–530. Discussion of modern practice in design and construction of brick cavity walls; comparative strength of solid and cavity walls; damp-proofing; comparative heat transmission of solid and cavity walls; costs.

SURVEYING

ROADS AND STREETS, CURVES. Reverse Curves on Highways, H. Criswell. *Roads & Road Constr.*, vol. 18, no. 215, Nov. 1, 1940, pp. 204–207. Outline of method of inserting transition curves between two circular curves of opposite direction, connected by short tangent, circular arcs being considered as fixed; numerical examples. (To be continued.)

TRAFFIC CONTROL

HIGHWAY TRAFFIC SIGNS, SIGNALS AND MARKINGS. Experience of Cities with Painted Traffic Lines. *Am. Public Works Assn.—Bul.*, No. 4, Aug. 1940, 28 pp. 50 cents. Information on experience of American cities with painted traffic lines, including durability, frequency of repainting, and other pertinent factors; specifications in use in six cities; information on special road exposure tests.

STREET TRAFFIC CONTROL. Expanding War Industries Cause Serious Traffic Problems. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 95–97. Report on congestion on streets and highways serving industrial plants building military airplanes, shipyards, and other plants with war orders; conditions at Los Angeles and Seattle: steps proposed to relieve congestion; parking areas needed.

TUNNELS

SUBWAY CONSTRUCTION, CHICAGO. Construction of Chicago's Initial System of Subways, V. E. Gunlock. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 497–508. Report on construction of subway in Chicago by tunneling methods, through underlying stratum of soft blue clay; methods of placing concrete control to insure sound concrete; excavation; shield mining.

SUBWAY CONSTRUCTION, CHICAGO. Shield Tunneling on Chicago Subways. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 158–163. Driving of 20,000 ft of single-track tunnels for new Chicago subway, using four shields under compressed air, at average advance of 25 ft daily; removing concrete-lined Chicago freight tunnel ahead of shields and backfilling with sand; primary lining with fabricated structural steel segments; mining out of areas for stations; design of shield tunnels; plant layout; shield operation.

SUBWAYS, CHICAGO. Design of Chicago's Initial System of Subways, P. F. Girard. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 473–495. Report on location and structural design of Chicago's 7.7 miles, double tube, deep-level subway; typical cross sections; foundations; auxiliary structures; mezzanine stations; design of track tunnel sections.

VENTILATION. Tunnel Ventilation, R. Smillie. *Heating, Piping & Air Conditioning*, vol. 13, no. 1, Jan. 1941, pp. 4–5. Description of ventilation system of new Bankhead tunnel, Mobile, Ala.; in system used, fresh air is drawn into both portals and carried longitudinally to midpoint of tunnel; at this point vitiated air is drawn through series of ports into duct below tunnel roadway, whence it flows to ventilation building on Blakely Island and is exhausted to atmosphere.

WATER SUPPLY, COLORADO. River Diversion at Green Mountain Dam. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 758–760. Construction of partly lined, 1,500-ft diversion tunnel around right end of Green Mountain Dam on Blue River 18 miles south of Kremmling, Colo., driven through unusual geologic formations of sandstone, shale, and porphyry intrusions; methods used in driving and lining tunnel; sinking of gate shaft; handling of concrete.

WATER SUPPLY, CONCRETE LINING. Tunnel Lining Practice on Delaware Aqueduct, C. M. Clark and G. Spann. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 325–348. Method used in concrete lining for deep rock pressure tunnel 13.5 to 19.5 ft in diameter, 85 miles long, which will carry water from upstate reservoirs to New York City; methods used in batching, transporting, mixing, and placing concrete; reinforcement and steel interlining; progress in construction of tunnel lining; specification for portland-cement and concrete aggregates.

WATER RESOURCES

FLOW OF WATER, UNDERGROUND. Present Status of Our Knowledge Regarding Hydraulics of Ground Water, O. E. Meinzer and L. K. Wenzel. *Economic Geology*, vol. 35, no. 8, Dec. 1940, pp. 915–941. Theoretical discussion of laminar and turbulent flow; Darcy's law; course and rate of movement of ground water; head in relation to movement; permeability of water-bearing materials; storage in relation to movement; hydraulics of wells; behavior of ground water in vicinity of discharging wells; recovery formula; extent of cone of depression. Bibliography.

WATER TREATMENT

DRINKING WATER, STORAGE EFFECT. Manganese in Loch Raven Reservoir, A. Wolman and R. B. Stegmaier, Jr. *Am. Water Works Assn.—J.*, vol. 32, no. 12, Dec. 1940, pp. 2015–2037. Study on effect of reservoir storage on composition of water, with special reference to annual variation of manganese content of water in Loch Raven Reservoir of Baltimore, Md.; hypothesis of manganese production in reservoirs; relation of manganese to other reservoir characteristics, such as bacteria and carbon dioxide; periods of high manganese content. Bibliography.

FILTRATION, HISTORY. Three Jewells—Pioneers in Mechanical Filtration, M. N. Baker. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, p. 179. Historical notes on careers of Omar Jewells and his sons, William and Ira—pioneers in rapid mechanical filtration of water.

OUTDOOR SWIMMING POOL. "Swimmin' Hole" with Modern Fittings, S. W. Sapirie. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 840–842. Development of Crab Orchard Lake at Carbondale, Ill., as recreational area, where treated water and other sanitary control features have been applied to natural swimming pool; working details of purification equipment and method of distributing treated water in lake; beach and bath house layout.

WATER WORKS ENGINEERING

AFRICA. Wasserwirtschaft in Afrika, K. Lanz. *Gas- u. Wasserfach*, vol. 83, no. 34, Aug. 24, 1940, pp. 409–415. Notes on water supply and water works development in former German colonies of Africa, in Union of South Africa, in Somaliland and in Valley of Nile River.

CANADA. Developments in Canadian Waterworks Practice 1850–1940, A. E. Berry. *Water & Sewage*, vol. 78, no. 12, Dec. 1940, pp. 9–18 and 43–45. Review of 90-year progress in development of municipal water works and water works engineering practice in Canada; statistical data on Canadian water works; review of Canadian water treatment practice.

MAINTENANCE AND REPAIR. Maintaining Water Service in Sub-Zero Weather, E. Farm. *Am. Water Works Assn.—J.*, vol. 32, no. 12, Dec. 1940, pp. 2060–2066. Maintenance of water meters and hydrants of Lexington Water Company, Lexington, Ky., during unusual cold spell of January and February 1940; cold weather precautions in operation of water works.

PENNS GROVE, N.J. Compact Water System Built Around Radial Well. *Am. City*, vol. 55, no. 12, Dec. 1940, pp. 56–57. Description of small water works plant of Penns Grove, N.J., featuring concrete caisson, 13-ft inside diameter, sunk in gravel formation to depth of 33 ft, receiving inflow from 7 radial 8-in. pipes; features of pump room built over caisson, including chemical treatment equipment.

SABOTAGE. Sabotage of Water Works. *Am. City*, vol. 55, no. 12, Dec. 1940, pp 35–37. Discussion of possible sabotage acts against water works; weak points of water works; measures for prevention and combating of sabotage of water works.

WATER SUPPLY TUNNELS, NEW YORK. Delaware Aqueduct—IX and X. *Eng. News-Rec.*, vol. 125, nos. 23 and 25, Dec. 5, 1940, pp. 761–763, and Dec. 19, pp. 22–26. Dec. 5: Caissons for cutoff wall; test installation; caisson equipment; bottom drainage; information obtained from sinking of exploratory caissons; overcoming skin friction. Dec. 19: Treatment for Delaware water; treatment facilities: chemical mixing equipment; aerator design details; chlorination equipment.

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

Photoelasticity Kit

A COMPLETE DEMONSTRATION KIT, comprising a Polaroid Projector Polariscope, a hand loading frame, and typical photoelastic structural models, has been made available by The Polarizing Instrument Co., 630 Fifth Avenue, New York, N.Y.

This kit offers convenient means of demonstrating the phenomena of photoelasticity. With it students of the subject may be given a vivid, visual expression of the internal stress reactions of loaded structural elements. Images of loaded plastic models of structural elements are projected on a screen with a common lantern-slide projector. The projected images show the varying color patterns in a strained model (held in a polariscope) as either tensile or compressive stresses are applied. Literature.

Burr Brown Associates

THE NATIONAL REPRESENTATIVES for Weirton steel sheet piling, Burr Brown Associates, Inc., recently moved to 347 Madison Ave., New York, N.Y. This firm also are sales representatives for Union Metal Manufacturing Company's corrugated steel sheet piling.

New Dry Developer Paper

FREDERICK POST CO., Chicago manufacturer of sensitized papers, offers a free supply of their new "VAPOpaper" blue line paper for tests.

The new paper, according to the manufacturer, embodies many improvements: 50% rag content bond; two "speeds" in sensitivity—regular and fast; two colors—deep royal blue and "Post" red; a cleaner, whiter background; and all lines in deeply colored contrast.

To owners of ammonia vapor machines Frederick Post is delivering a $2.50 stock of "VAPOpaper," asking only a brief report on its performance in return. Owners of these dry developer machines may secure a trial stock of "VAPOpaper" by sending the model or serial number of the machine with their request to the Frederick Post Co., Box 803, Chicago, Ill.

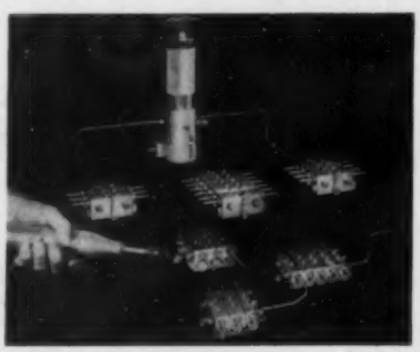
Low-Cost Searchlight

A NEW LOW-COST 18 in. 1,000/1,500 watt incandescent searchlight, designated Type S-5, has been announced by the General Electric Company. It is particularly adapted for use in protective lighting systems now being installed by industrial concerns. Some of its other lighting applications are railroad yards, construction projects, dams, locks, canals, and prisons.

The new searchlight is equipped for pilot-house or hand control, and comes with either a low or high pedestal. A highly efficient silvered glass parabolic provides accurate control of the light beam. A spherical auxiliary reflector in front of the lamp eliminates stray light and builds up beam intensity. The searchlight casing is made of sheet aluminum, which has enabled a substantial reduction in the cost of the unit. A glass door, clamped over the face of the searchlight, makes the unit weatherproof.

Centralized Lubrication

LOW COST POSITIVE centralized lubrication has been made possible for the first time, through the development of the Trabon non-reversing single inlet multi-outlet Distributor feeder and the new Trabon Series "MP" variable feed multi-outlet pump.



This improved feeder or distributor consists of a bank of three or more sections, each of which discharges a measured quantity of lubricant alternately through one or two discharge outlets which are direct connected to bearings. The capacity of different sections of the distributor may vary from 0.005 to 0.035 cu in.

The distributors can use either oil or grease as a lubricant and employ the positive feature exclusive with Trabon lubrication—i.e., the distributor must discharge lubricant from each and every outlet or the operator receives immediate warning. Booklet No. 141 gives further details of the Trabon lubricating system, which has been installed on movable bridges, dam gates, and similar heavy engineering structures. Trabon Engineering Corp., Cleveland, Ohio.

"Easy-Holding" Jackhamer

INGERSOLL-RAND COMPANY has just introduced a new 55-lb Jackhamer Rock Drill which they designate as the "Easy-Holding" JB-5. It is claimed that because of many new features incorporated in this drill the machine is much easier on the operator, and, consequently, permits greater output on the average drilling job.

One of the chief reasons for reduced vibration is a refined valve action, which also results in more economical use of compressed air. Another feature is an easy opening, long-life steel holder, hand or foot operated, which reduces the time and effort in changing drill steels. Other features include a drop forged blower valve handle, large exhaust opening, two-piece chuck, thicker cylinder walls, and large bearing surfaces within the drill. Lubrication is positive and thorough. Booklet, Form 2734, gives interesting particulars of this Jackhamer; copies from the Ingersoll-Rand Co., 11 Broadway, New York, N.Y.

Cement-Conveying Hose

A NEW LINE OF cement-handling hose, built especially to meet operating conditions created by new techniques in bulk handling of cement, is announced by The B. F. Goodrich Co., Akron, Ohio.

The new hose is made with a $^1/_8$-in. tube of Armorite, a specialized rubber compound designed to resist abrasion, strong wrapped fabric and round wire reinforcement, with a $^3/_{64}$-in. rubber cover. It comes in inside diameters ranging from 4 to $6^3/_4$ in.

Rubber Joint Sealer

A NEW MEDIUM for the sealing of expansion joints and concrete highways and slab construction is announced by Rubber Associates, Inc., Rockefeller Center, New York, N.Y. It is a rubber compound of the hot-poured type and is known as Rai-Seal. It is recommended as a top seal for a depth of one inch to one and one-half inches over a preformed strip of the non-extruding type. Rai-Seal is melted at 400 to 450 F in a regular heating kettle, poured into the joint, and may be exposed to traffic in from ten to twenty minutes.

The manufacturer claims the new compound, which has been tested in actual highway use for four years, provides adhesion to concrete surfaces, resiliency at low temperature while being extended, and non-flowing properties at continued summer temperatures while under compression. The new product is made in concrete color to blend with new concrete pavements and structures, and in black for resealing.

New Sump and Bilge Pumps

FAIRBANKS, MORSE & Co., 600 South Michigan Ave., Chicago, Ill., has just announced a new line of "non-clogging" centrifugal pumps specifically designed for intermittent-duty sump or bilge pumping, wet-pit, or submerged service. They are known as Fairbanks-Morse 5410SS submerged suspended sump and bilge pumps.

Designed for such typical industrial or municipal installations as disposal of surface or storm water or drainage of deep basements or underpasses, Fairbanks-Morse 5410SS pumps are available in 2-,3-,4-,and5-in. sizes for capacities up to 1,400 gal per min for heads up to 120 ft and settings up to 25 ft. The pumps in the larger discharge sizes handle solids up to 3 in. in diameter without difficulty. Installation of the new F-M 5410SS pumps is simple and inexpensive. No dry, watertight pump pit is required, for the pump is designed for suspension from the floor level into a sump or bilge. Multiple pump units may be suspended in one sump, where large variation in flow requires reserve pumping capacity. An attractive 14-page bulletin is available.

Big Tractor Shovel

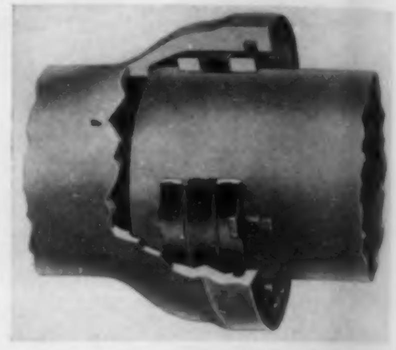
A NEW MACHINE, Model T 7, reported to be the biggest, most powerful tractor shovel ever built, has been announced by the Trackson Co. This Traxcavator is available with 2 or $2^1/_2$ cu yd bucket, and is capable of handling any type of digging or dirt-moving with ease, speed, and at low cost. Mounted on the "Caterpillar" D 7 Tractor, the T 7 Traxcavator is said to be low in initial cost, operating costs, and yardage costs, and may be used profitably on a wide variety of digging, loading, grading, and dirt-moving operations, as a shovel and loader, and also as a scraper, bulldozer, anglegrader, and trail-builder.

In spite of its large size, operators find the T 7 Traxcavator fast, mobile, and agile; it travels at speeds up to six miles per hour, turns in its own tracks, and has a fast loading cycle. Quickly mounted bulldozer blade and other special attachments are available to increase the usefulness of this machine. The big T 7 will be sold and serviced by all "Caterpillar" dealers. For special bulletin on the T 7, write to Trackson Co., Milwaukee, Wis.

Cast Iron Pipe Joint

A SIMPLE, EASY TO INSTALL mechanical joint is the Dresser Bellmaster Joint, Style 85, announced by the Dresser Manufacturing Co., Bradford, Penna.

The Bellmaster is a single-gasketed, self-contained mechanical joint. It consists of an inner ring, an armored gasket, an outer ring, and six cap screws, all factory assembled into a single unit. In use the Bellmaster is inserted and locked into place in the bell end of the pipe built to accommodate this joint. The spigot end is "stabbed in," and the cap screws are tightened to seal the gasket against spigot and bell.



The manufacturer reports that this joint is low in first cost, offers complete protection against corrosion, greater deflection without leakage, tightness under all pressures, savings in laying time, and possesses excellent expansion qualities.

Leading cast iron pipe manufacturers can furnish pipe with bell ends suitable for Bellmaster Joints. The Style 85 Bellmaster is at present available in the following CIP sizes—4 in., 6 in., 8 in., 10 in., 12 in. and 16 in. Other sizes will soon be offered to meet the demand for pipe with this new, tested joint.

Power Control Units

A COMPLETE LINE OF single and two-drum power control winches for operating cable-controlled equipment with International TracTracTors and other tractors is announced by Bucyrus-Erie Co.

In the new Bucyrus-Erie planetary drive winches, clutch and brake drums are separate and each drum has but one heat-generating surface; bands are external and contact 93.8 per cent of the full circumference of the drum, spreading friction pressures over a large area. All bands and drum friction surfaces are exposed to open air. Thus, say the designers, heat is carried off before it can build up to temperatures which would damage linings, ruin oil seals, or cause excessive expansion and contraction with its resulting effect on clutch and brake adjustment.

The wide, large-diameter external clutch and brake bands are interchangeable. One adjustment on each band, in full view of the operator, compensates for wear, and bands are easily replaced in the field with ordinary tools. Full details of the new Bucyrus-Erie single and two-drum winches are given in the illustrated bulletin PCU-1; write Bucyrus-Erie Co., South Milwaukee, Wis.

Literature Available

CHLORINATION OF WATER—A four-page folder on the Aqua Ammoniation for Chloramine Treatment of Water had been made available by Proportioneers, Inc., 14 Codding St., Providence, R.I.

DIESEL ENGINES—In a 48-page catalog, Caterpillar Tractor Co. has X-rayed its line of Diesel engines; and has presented a detailed discussion of mechanical features and manufacturing methods. The booklet, Form 5850, which is a complete discussion of the whys and hows of Diesel engine design, makes profuse use of cutaway photographs. The various engine parts are treated separately; crankcases, crankshafts, cylinder liners, cylinders, valves, timing gears, governors, fuel systems, etc. A section of the catalog covers maximum, rated, and continuous hp ratings of the engines. Complete specifications, dimensions, and performance charts are also given. Caterpillar Tractor Co., Peoria, Ill.

HIGHWAY SUBDRAINAGE—"What happens when your roads break up," is the title of the latest Armco booklet on the subject of highway subdrainage. Armco Drainage Products Association, Middletown, Ohio.

INCONEL PROPERTIES—This 1941 edition of Bulletin T-7 contains revised information on mechanical properties at ordinary and at elevated temperatures of Inconel. The sections on Working Properties and Corrosion Resistance have been revised in accordance with the latest mill and field experiences. A general description of all mill products has been added. Development and Research Division, The International Nickel Co., Inc., 67 Wall St., New York, N.Y.

PORTABLE SUBSTATIONS—Portable substations, available in all voltage ratings up to 69 kv and in capacities up to 4,500 kva, are described in a new 8-page bulletin, No. B-2281, announced by Westinghouse. Typical trailer mounted substations are illustrated; engineering details such as core and coils, heat exchanges, and automatic protection are explained. Application features are listed. Address Department 7-N-20, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penna.

PUMPING UNITS—Complete self-contained engine-driven pumping units for service entirely independent of any outside source of power supply are described in leaflet B-6153. It illustrates various sizes and types of units applicable to irrigation, gravel washing, fire protection, and for municipal stand-by service. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

WIRE ROPE—A fifty-page booklet, "Valuable facts about the use and care of wire rope," Form No. 6162, gives helpful information and suggestions for the proper handling and maintenance of wire rope. It covers such important subjects as unreeling and uncoiling, seizings, attaching of clips and sockets, splicings, lubrication, gaging, etc. American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio.

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